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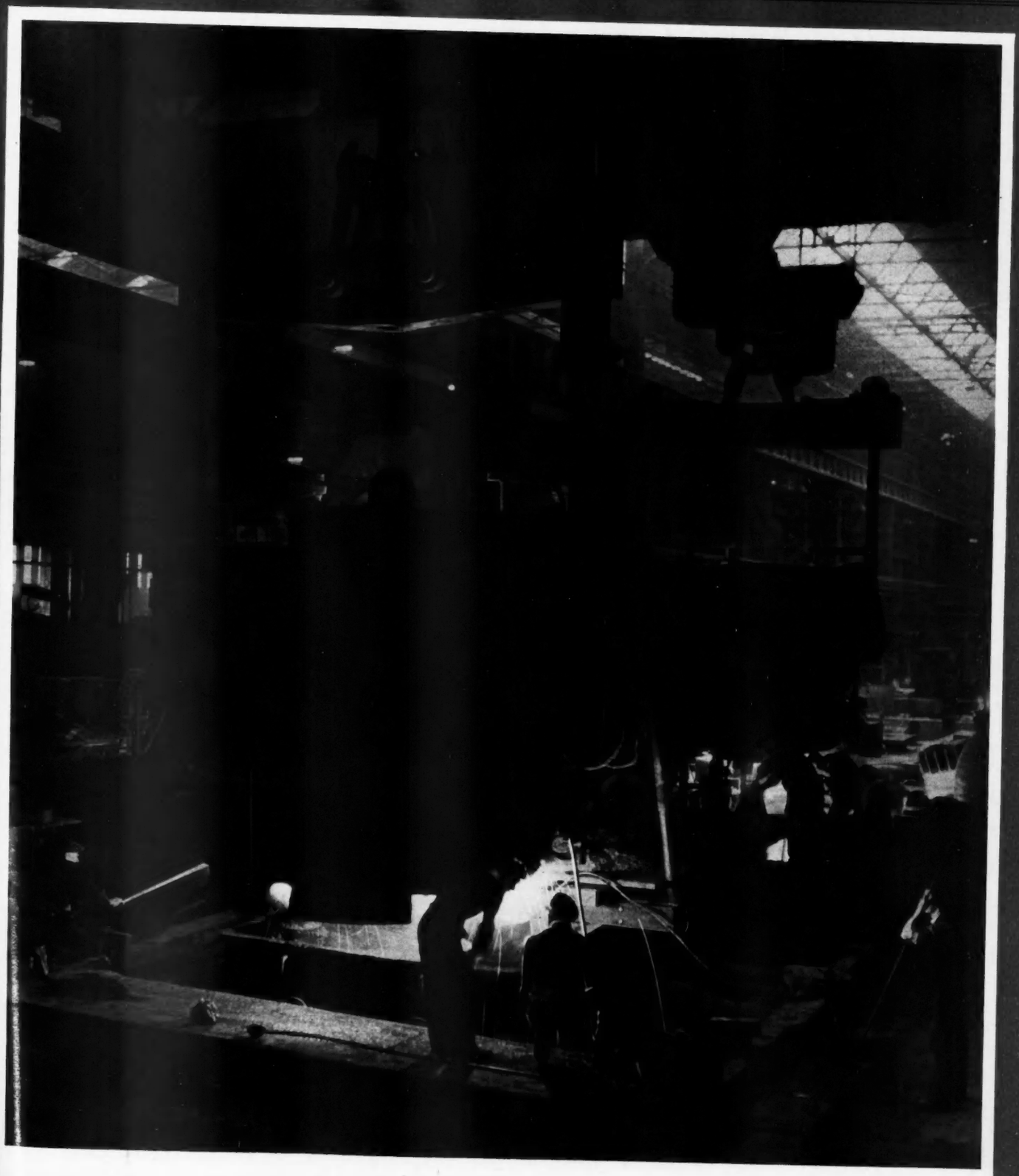

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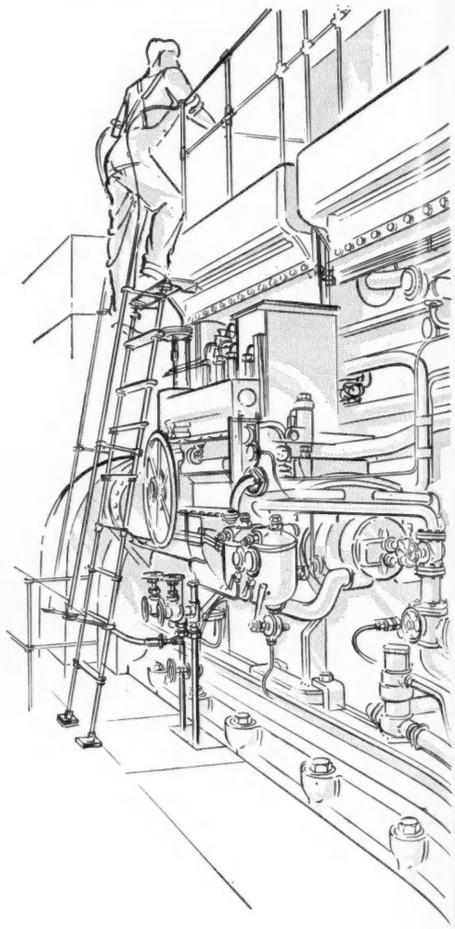

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STANDARD LOCOMOTIVES IN INDIA 50 YEARS AGO.

By E. C. POULTNEY, O.B.E.

THE considerable work recently carried out by British Railways in formulating standard steam locomotives of different wheel classifications has attracted a large amount of interest. It brings to mind the important innovations inaugurated in November, 1903, just half a century ago, when the standardisation of locomotives for the Indian railways was undertaken by the British Engineering Standards Committee and the first standard engines were designed. The object of the present article is to recall the work then undertaken by presenting a few brief notes on this early effort, covering the production of standard locomotive types for the Indian broad and narrow gauge railways.

The use of locomotives of a standard design for various classes of traffic was discussed when a conference of the locomotive superintendents of the railways of India met at Calcutta in 1901, and subsequently a locomotive committee, convened at the instance of the Engineering Standards Committee, commenced the great work of preparing proposals for certain locomotive designs which could form standard types for passenger and freight services.

THE LOCOMOTIVE COMMITTEE.

The personnel comprising the locomotive standards committee was composed of members representing the following interests: Government departments, consulting engineers of various railways in India, locomotive builders, locomotive superintendents of British railways, locomotive material manufacturers, and the Calcutta Locomotive Conference. This locomotive sub-committee was assisted by a conference consisting of consulting engineers associated with several Indian railway systems and representatives of British locomotive manufacturers, who prepared the designs and general specifications for proposed standard locomotive types and who took into consideration recommendations put forward by the Calcutta Conference.

Proposals ultimately formulated by the locomotive sub-committee were then forwarded to the Engineering Standards Committee for final approval by the Secretary of State for India. Concurrently with the formation of the locomotive committee, five additional sub-committees were appointed to prepare standard specifications governing the manufacture of the basic materials used in locomotive construction, including steel, materials for boiler plates, axles, springs, tyres and tyre contours, copper firebox plates, pipes and rods for firebox stays, as well as brass and copper boiler tubes. These specifications ultimately became the now well-known standard requirements for the manufacture of these particular components.

The first series of standard locomotive designs to receive approval embraced proposals for the following classes for broad and metre gauge locomotives.

Broad (5 ft. 6 in.) Gauge Lines.

(*a*) Type 4-4-0 locomotive with six-wheeled tender for passenger service (Fig. 1).

(*b*) Type 0-6-0 locomotive with six-wheeled tender for freight service (Fig. 2).

Metre (3 ft. 3⅜ in.) Gauge Lines.

(*a*) Type 4-6-0 locomotive with six-wheeled tender for passenger service (Fig. 3).

(*b*) Type 4-6-0 locomotive with six-wheeled tender for mixed traffic, passenger or freight (Fig. 4).

(*c*) Type 4-8-0 locomotive with six-wheeled tender for heavy freight services (Fig. 5).

5 FT. 6 IN. GAUGE ENGINES.

Taking, in the first instance, the 4-4-0 locomotives designed for mail and general passenger trains, the boiler was designed for a working pressure of 180 lb. per square inch and with the largest amount of heating surface consistent with the specified weights. The Belpaire pattern of firebox was adopted for the reason, as stated by the committee, that "it gives more steam and water capacity than the usual arrangement with semi-circular outside shell and girder stays for the inside firebox, and with increasing pressures and larger fireboxes the weight of girders becomes excessive and direct staying has to be resorted to." It was also pointed out that the Belpaire form of construction was already widely used on English railways and had, moreover, been used for new engines on the Great Indian Peninsula and Bengal-Nagpur Railways.

The diameter of the coupled wheels was fixed at 74 in., as this size conformed with previous Indian practice and thus enabled the use of tyres interchangeable with those already largely standard for passenger engines. The cylinders, inside the frames in common with previous broad-gauge designs, had balance valves, arranged in steam chests above the cylinders, operated by Stephenson's valve gear through rocking levers. When deciding this feature, the committee had in mind recently constructed locomotives for the I.S.R. (North Western) having the same arrangement, which was reported to be satisfactory. Also, similar valves and valve gear were in use on British lines at that period.

The 0-6-0 engine for general freight traffic on the broad-gauge lines followed normal practice at that time and was designed to take the same boiler and cylinders as the 4-4-0 mail engines. In fact, interchangeability of all important components was extensively incorporated. The diameter of coupled wheels was fixed at 61½ in. so that the tyres would interchange with those already common on the broad-gauge systems.

The passenger and freight engines had standard tenders of the six-wheeled pattern, having a tank capacity of 3,000 Imperial gallons of water and space for 7½ tons of coal. The weights in working order were in each case 40½ tons.

METRE-GAUGE ENGINES.

The new standard locomotives constructed for the 3 ft. 3⅜ in. gauge lines represented a considerable advance on those previously in general use in India.

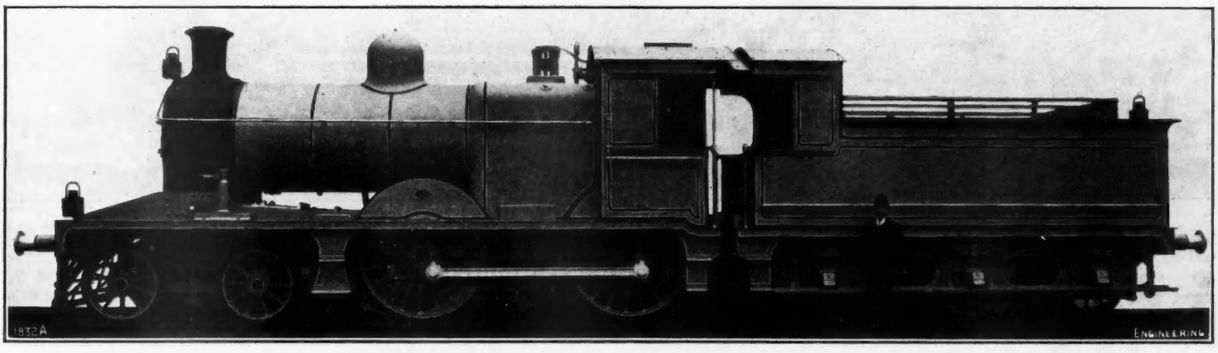


FIG. 1. STANDARD 4-4-0 PASSENGER LOCOMOTIVE, 5 FT. 6 IN. GAUGE.

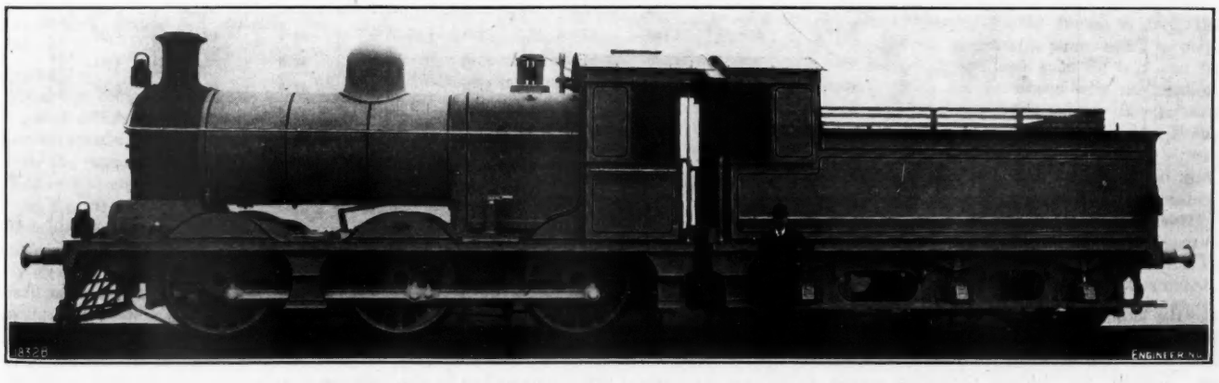


FIG. 2. STANDARD 0-6-0 FREIGHT LOCOMOTIVE, 5 FT. 6 IN. GAUGE.

STANDARD LOCOMOTIVES OF THE INDIAN RAILWAYS.

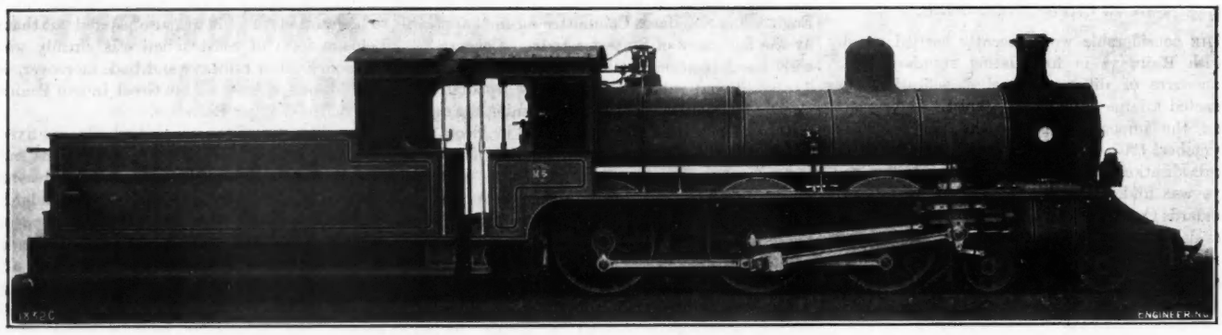


FIG. 3. METRE-GAUGE 4-6-0 PASSENGER LOCOMOTIVE.

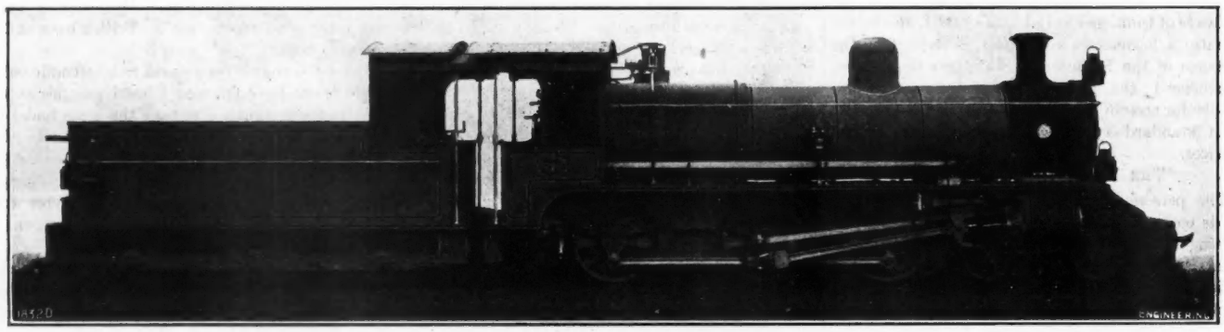


FIG. 4. METRE-GAUGE 4-6-0 MIXED-TRAFFIC LOCOMOTIVE.

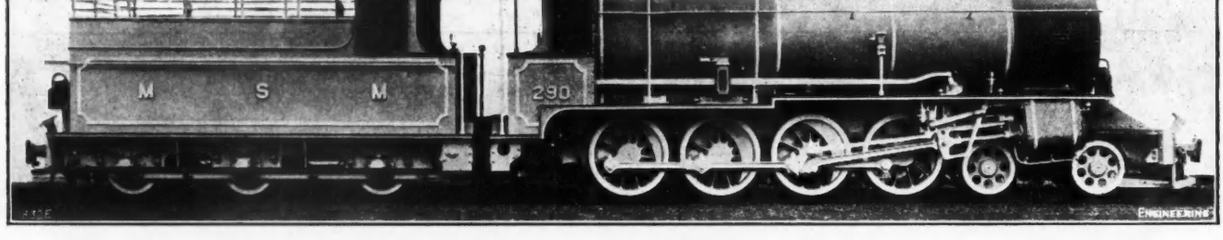


FIG. 5. METRE-GAUGE 4-8-0 HEAVY FREIGHT LOCOMOTIVE.

PRINCIPAL DIMENSIONS OF STANDARD LOCOMOTIVES.

Type.	Gauge, Ft.-In.	Cylinders, Dia. and Stroke, In.	Diameter of Driving Wheels, In.	Boiler Dia., In.	Heating Surfaces, Sq. Ft.			Grate Area, Sq. Ft.	Engine Weights.		Tractive Force,† Lb.	Factor of Adhesion.	Boiler Pressure, Lb. per sq. in.
					Firebox.	Tubes.	Total.		On Drivers, Tons.	Total, Tons.			
4-4-0	5—6	18½ × 26	74	56½	128	1,230	1,358	25·3	33·2	52·0	18,390	4·02	180
				61½*	150	1,453	1,603	27·0	35·0	54·5	18,390	4·28	
0-6-0			61½	56½	128	1,230	1,358	25·3	49·0	49·0	22,368	4·91	
				61½*	150	1,453	1,603	27·0	51·5	51·5	22,368	5·18	
4-6-0	3—3½	15½ × 22	57	46½	108	954	1,062	16·0	26·7	34·3	14,183	4·23	
4-6-0		15 × 22	48	46½					26·4	34·0	15,774	3·75	
4-8-0		16 × 22	43	53½	126	1,166	1,292	17·5	32·5	40·5	20,020	3·62	
Original I.S.R. Standard Metre-Gauge Locomotives.													
4-4-0‡ ("O" Class)		14 × 20	53	—	52·4	496·3	548·7	10·58	16·4	24·0	8,806	4·14	140
0-6-0‡ ("F" Class)		14 × 20	42½	—	58·2	590	648·2	12·0	21·2	21·2	10,950	4·33	

* Alternative boiler with barrel 61½ in. in diameter outside, smallest course 11 ft. long. † Tractive force based on 85 per cent. of boiler pressure.
‡ Outside frames, outside cylinders, inside valve gear.

Unlike the locomotives then in service, they were built with inside main frames, in contrast to the outside frames characteristic of former standard types. Actually, the Calcutta Conference recommended the outside-frame design. It was pointed out, however, that difficulties anticipated in the lubrication and examination of inside-frame engines on the metre-gauge railways had not materialised in the case of engines of recent construction for the Bengal and North Western and Rohilkund and Kumaon railways. In selecting the inside-frame type, the Standards Committee further pointed out that this design enabled the distance between cylinder centres to be reduced, eliminated outside fly-cranks and assisted in the adequate staying of

the main frames. One of the reasons for the use of outside frames for narrow-gauge lines has always been that it enables a larger firebox with more grate area to be fitted; however, in designing the new engines the actual width of the firebox was not reduced by more than 2 in.

A feature of the older metre-gauge engines was the use of outside main framing and, in consequence, outside cranks for the coupling rods, which were of the Hall pattern. With this design, the cranks were keyed on the axles and the crank bosses formed the main journal bearings, which rotated in the axleboxes, the claim being made that this form of construction enabled the cylinder centres to be brought in closer to the outside frames.

Here it may be interesting to recall that, when discussing a paper on the "Standardisation of Indian Locomotives," read before the Institution of Mechanical Engineers by Cyril Hitchcock in 1910, Sir Seymour Tritton stated that, as traffic demands increased, the mortality among these cranks was very great. This historic paper will be found in ENGINEERING, vol. 90, page 614 (1910).

The standard metre-gauge engines were designed to take the place of the existing O and F classes, of which large numbers had been built but were then not sufficiently powerful to meet the traffic demands. To take the place of these smaller engines, the two 4-6-0 designs were built, while, to handle the heavier freight trains, the 4-8-0 wheel arrangement was introduced. Apart from the large increase in size and power and the change in the design of the main frames, together with a Belpaire-firebox boiler of much larger size, an important change was the introduction of outside cylinders with Walschaerts valve motion, adopted because, "being outside the frames and wheels, it is easily examined and oiled and it permits the use of balanced slide valves."

As was the case with the broad-gauge locomotives, the tenders for the three metre-gauge designs were identical and of the six-wheeled pattern, with a tank for 3,000 Imperial gallons of water and space for 4 tons of coal. The tenders had a full weight of 23½ tons. So far as the construction of these standard locomotives is concerned, mention should be made of the complete lists of requirements governing construction which were provided by means of a memorandum called "Instructions to Designers," which set out in considerable detail the lines to be followed in order to comply with the requirements of the Conference responsible for the different designs. Generally, the aim was to maintain standard methods of construction, together with standardised and therefore interchangeable major components for any given type and, as far as possible, between one type or class and another. However, to comply with practices on different railways, some latitude was recognised as being desirable, especially so far as the arrangement of the smokebox and chimney was concerned and the application of spark-arresting devices, if used. Variations in the design and arrangement of grates and ashpans were also allowed.

BRAKES.

The standard continuous brake on Indian railways is the automatic vacuum, and locomotives built to the new standards might be fitted with this brake, either on the engine and tender, or the locomotive might have a steam brake only, acting simultaneously on the engine and tender, according to the requirements of the railway concerned. All the materials used in construction were required to comply with the detailed specifications drawn up by the small sub-committees.

Leading particulars of these standard locomotives are given in the table opposite. The dimensions and weights given conform in general to the engines and tenders as built. In some instances there may have been some slight deviations, though for the most part these were not important. As a point of some interest, the principal dimensions of the old O and F metre-gauge engines are included for comparison with the B.E.S.A. designs.

It will be noted that in the case of the broad-gauge 4-4-0 and 0-6-0 locomotives, particulars are given of a revised standard boiler of larger dimensions than the original. While rather beyond the scope of this article, it may be said that the enlarged boiler was designed at a later date, following upon advice received from India that a larger boiler was thought to be desirable in certain instances. The revised design of boiler for these engines dates from about 1910, and the first engines to be fitted were of the standard 4-4-0 type, built by Nasmyth, Wilson and Company in 1912. Full particulars with drawings appeared in ENGINEERING, vol. 93, page 452 (1912).

The author's interest in these early B.E.S.A. standards is in part due to his having been concerned with the inspection of materials and components used in their construction. The work undertaken by those responsible for the standard engines was undoubtedlv a milestone on the road of progress in locomotive construction. In conclusion, the author desires to acknowledge the considerable assistance in the preparation of this article received from the Locomotive Manufacturers' Association of Great Britain, and from the North British Locomotive Company and the Vulcan Foundry, Limited, for the photographs used in the illustrations.

LITERATURE.

Billings and Water Power in Brazil.

BY ADOLPH J. ACKERMAN. Published by the Author at Madison, Wisconsin, and by the American Society of Civil Engineers, 29, West 39th Street. New York 18, N.Y. U.S.A. [Price 7 dols.]

IN ENGINEERING of July 1 and 8, 1949, we published an illustrated description of the heightening of the Lages dam, forming part of the hydro-electric system supplying the city of Rio de Janeiro, from 32 m. above the river bed to 62 m. In addition, the dam was pierced by two new intake tunnels—an operation which was claimed at the time to be unique in civil engineering, since it was undertaken while the dam was holding back its full head of water. The engineer on whom rested the decision to take this unusual step was Asa White Kenney Billings, at the time vice-president of the Rio de Janeiro Tramway, Light and Power Company, who was in charge of all the hydroelectric power developments in Brazil that were sponsored by the Brazilian Traction Light and Power Company, of Toronto, Ontario. After 25 years in Brazil, Mr. Billings retired in 1946 and settled in California, where he died on November 3, 1949. This book, by a civil engineer who was closely associated with him for many years, is at once a tribute to his memory and a stimulating review of an exceptionally fruitful career; as the author describes it, "a perfect example of technical assistance in action for underdeveloped countries—by private enterprise."

Billings was born in Omaha, Nebraska, in 1876, and, while still at school, became fired with the ambition to become an electrical engineer. Leaving school at 14, he took a job as a labourer in the newly-established Omaha electric-light plant until, a year later, he went to Harvard University, where he took a B.A. degree in 1895, M.A. in 1896, and, almost incidentally, learned Spanish. During the vacations, he worked for various electric power companies, one of whom, the Consolidated Traction Company of Pittsburgh, Pa., engaged him, after he had graduated, to supervise the construction of street tramways and a steam power plant. He was then 23. After a remarkable succession of responsible posts, he joined Dr. F. S. Pearson, a New York consulting engineer and founder of the Brazilian Traction, Light and Power Company, as his assistant. Pearson sent him first to Texas, to supervise the construction of the Medina irrigation dam, where he made some notable improvements in concreting methods; and then to Spain, on the Talarn and Camarasa dams. He returned to New York in January, 1917, and set up as a consultant, but, on the entry of the United States into the war three months later, he was commissioned in the Naval Corps of Civil Engineers and served with them until the end of the war.

After various investigations, etc., of hydro-electric schemes in Europe and America, Billings joined the Canadian and General Finance Company, of Toronto, who had taken over sundry of the business connections of the F. S. Pearson Company, and it was on their behalf that he went in 1922 to Brazil, where the most important works of his career were carried out. Chief among them was the exploitation of the water-power resources of the Serra do Mar, the high plateau escarpment which runs parallel with the Brazilian coast-line for nearly 1,300 miles. The chain of dams and hydroelectric stations which he constructed there to serve the cities of Saõ Paulo, Santos and Rio de Janeiro forms one of the largest systems of the kind in the world, fully deserving the honours conferred upon him by the Brazilian Government and by many public authorities. The last of them, a bare six months before he died, was the decision that the Rio Grande Reservoir, the largest artificial lake in South America, should be renamed Lake Billings. The magnitude of the works that Billings carried through so successfully is well brought out in Mr. Ackerman's liberally-illustrated book, which should be an inspiration to many young engineers as well as an *aide-mémoire* to their elders.

The Atomisation of Liquid Fuels.

BY PROFESSOR E. GIFFEN, D.Sc., M.I.Mech.E., and DR. A. MURAZ W, Ph.D., A.M.I.Mech.E. Chapman and Hall Limited, 37, Essex Street, London, W.C.2. [Price 36s.]

DR. GIFFEN'S interest in the atomisation of liquid fuels goes back many years, and during that period the subject has developed in many directions, especially under the stimulus of war; one of the most important studies, indeed, has been the prevention of premature atomisation, in the case of flame-throwing weapons. This, however, is a field that does not come within the scope of the present work, which is concerned primarily with the processes of atomisation, the means by which it is accomplished, the effect on spray characteristics of the physical properties of the sprayed liquid and of the gaseous medium into which it is sprayed, and—a section of particular interest—experimental methods for assessing full-spray characteristics. Many other associated topics are discussed, of course, but these are the main divisions of the authors' survey.

The book was published in the present year, but the date appended to the preface is July, 1952; which, bearing in mind the time needed to prepare and print technical and scientific text and illustrations, may be the reason why no mention is made of the flame-radiation experiments carried out over the past two years at Ijmuiden, Holland. Radiation of heat from flames, is not, *per se*, within the scope of the book, but we understand that, in the course of these experiments, a considerable amount of useful data on nozzle design and characteristics was obtained, as it were, as a by-product; if so, it is a pity that it could not be included. There will be opportunities to do so, no doubt, in subsequent editions, for it seems reasonably safe to predict a long and sustained circulation for a book which links so closely and presents so clearly the practical and the purely scientific aspects of a subject which, as the authors observe, still presents many unsolved problems.

THE PLASTIC DESIGN OF GRILLAGES.

By DR. JACQUES HEYMAN.

A GRILLAGE of beams is used, in general, to support some form of sheeting or plating subjected to a transverse pressure distribution. In the work described in this article, it is assumed that this plating has no structural strength either as a membrane or in bending, so that attention is confined to the behaviour of the grillage alone. The load distribution on the individual beams of an actual grillage will depend on the method of attachment of the plating; some members may carry distributed loads, and others may have concentrated point loads. To simplify the theoretical work, and to enable the results to be checked experimentally, all loads have been assumed to act at the joints of the grillages under investigation. This simplification in no way restricts the theoretical method proposed for the plastic design of such structures.

The plastic behaviour of grillages has already received some attention theoretically*; the same assumption will be made here that the members of the grillage lie all in the same plane, and that all loads act perpendicularly to this plane. If the members are rigidly joined at their points of intersection, then they will be acted upon, in general, by shear forces parallel to the applied loads, and by a moment and torque the axes of which lie in the plane. Bending moments having axes perpendicular to the plane, and shear forces in the plane, are assumed to be zero. The customary structural assumption is made that deformations are small compared with the overall dimensions of the frame, so that equilibrium conditions may be satisfied in the undeformed rather than in the deformed state.

It is found theoretically that the effect of the torque acting in the members is to increase the work at a plastic hinge necessary to cause failure, and thus to increase the collapse load of the structure as a whole. It will be seen from the Appendix, however, that, for the type of grillage considered, this increase is negligible for members of I section; and the experimental work below is concerned with grillages in which the joints are not capable of transmitting torques.

An account was given recently† of an experimental investigation of the behaviour of rectangular portal frames when loaded in the plastic range up to collapse. These tests were carried out on frames built up of miniature sections, and the present article reports the use of similar techniques to confirm the behaviour of rectangular grillages. The work thus confirms the general behaviour of this type of structure; in particular, the theoretical modes of failure and calculated collapse loads are found to be observed in the tests.

THEORETICAL WORK.

If the torque in the members of a grillage is zero, a plastic hinge will be formed at some section of the structure when the moment there reaches the value M_p, where M_p is the fully plastic moment of the beam at the section. (In general, it is assumed that M_p refers to the part of the structure under consideration; the fully plastic moment may vary from point to point according to the size of member used, though all the grillages discussed here are built up of beams with identical properties.)

Consider a square opening of side length L, as shown in Fig. 1, herewith; the problem is to

* "The Limit Design of a Transversely Loaded Square Grid," by Dr. Jacques Heyman. *Jl. of App. Mechanics*, vol. 19, No. 2 (1952).

† "Tests on Miniature Portal Frames," by J. F. Baker and J. Heyman. *Structural Engineer*, vol. 28, No. 6, (1950).

PLASTIC DESIGN OF GRILLAGES.

Fig. 1.

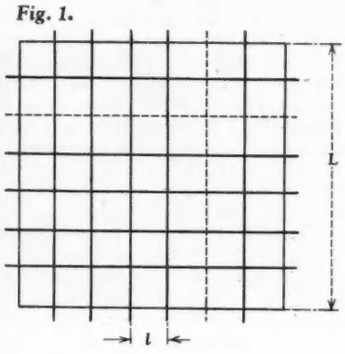


Fig. 2.

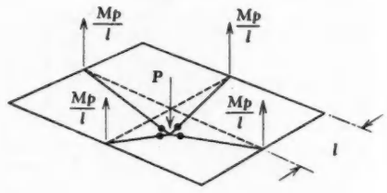


Fig. 3.

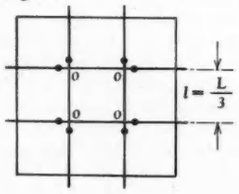


Fig. 4.

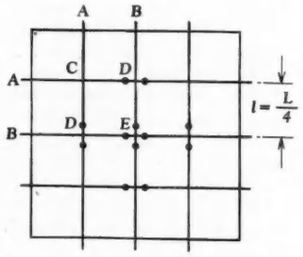


Fig. 5.

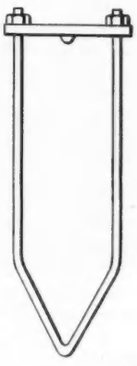


Fig. 6.

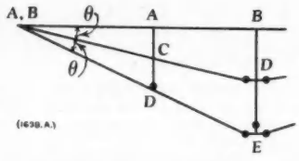


Fig. 7.

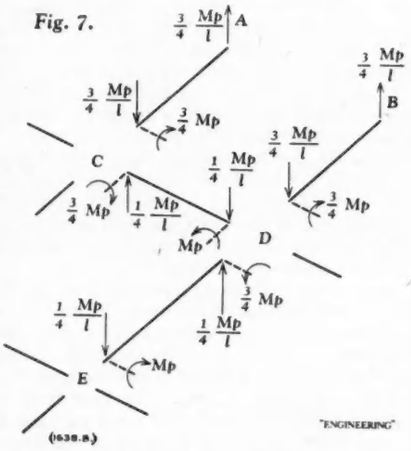
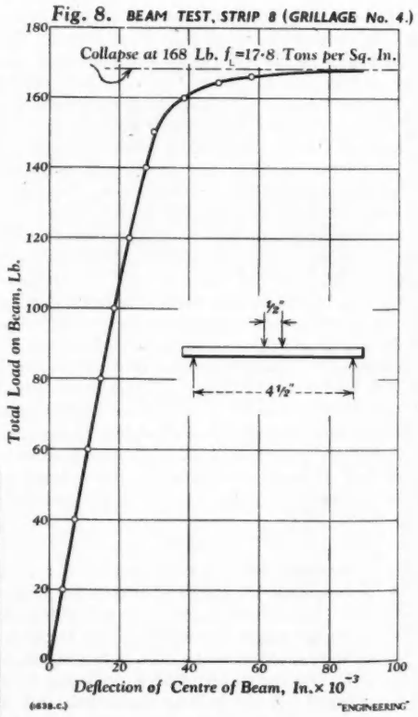


Fig. 8. BEAM TEST, STRIP 8 (GRILLAGE No. 4.)



cover this area with a grillage of beams in order to support a load P, uniformly distributed. For the sake of simplicity, the load will be taken as split into equal concentrated loads of value p acting at the joints of the grillage. If there are n equally spaced beams spanning in either direction, there will be n^2 joints, so that

$$P = n^2 p. \quad . \quad . \quad (1)$$

In addition, the elementary span length will be denoted by l, as shown in Fig. 1, so that

$$(n + 1)\,l = L. \quad . \quad . \quad (2)$$

Suppose that a very simple grillage is formed by placing two equal beams of fully plastic moment M_p to intersect at right angles in the centre of the square opening. It is easy to see that collapse of this grillage will occur when a plastic hinge is formed under the load at the joint in each of the two beams, the ends of the beams being assumed to be simply supported. If the material at the joint itself is so strong that failure cannot occur there, the hinges being displaced slightly, collapse takes place by the mechanism of one degree of freedom shown in Fig. 2, herewith, the four dots representing the positions of the four plastic hinges. These hinges are all formed under the action of bending alone, so the rigidity of the joint does not come into question.

By considering the vertical equilibrium,

$$P = 4\frac{M_p}{l}. \qquad . \quad . \quad (3)$$

This value for P may also be derived from the principle of virtual work, which will be found to be of use when discussing more complicated grillages. If the change in angle at the ends of the four beams is θ, due to a small displacement of the collapse-state mechanism, the change in angle of discontinuity at each of the four plastic hinges will also be θ, on the usual assumption that neither the elastic nor the plastic deflections effectively alters the overall geometry of the structure. Now the plastic work done in a hinge is equal to the angle change multiplied by the fully plastic moment, and, equating this total work to the work done by the load,

$$P\,l\,\theta = 4\,M_p\,\theta, \qquad . \quad . \quad (4)$$

which leads directly to equation (3). In practice, two hinges would not be formed in the same beam, one on either side of the joint, but only one would occur; equation (4) remains unaffected, since the rotation at this single hinge would be just 2θ, so that the work done is equal to that done by the ideal two hinges.

The collapse of the 2 by 2 beam grillage shown in Fig. 3, on page 804, again introduces no twisting moments in the members, whether the joints are rigid or not. The loads $p = \frac{1}{4}$ P act at the joints O, and hinges are formed as shown, with the beams forming the square 0, 0, 0, 0, also subjected to the full plastic moment. Virtual work or vertical equilibrium gives

$$p\,l = 2\,M_p. \qquad . \quad . \quad (5)$$

The analysis of the 3 by 3 beam grillage shown in Fig. 4, on page 804, is more complicated. In cases like this, the use of the equation of virtual work greatly simplfies the labour, and the calculations are best set out in tabular form, as shown in Table I.

Let the arrangement of hinges shown in Fig. 4 be assumed to be the correct mechanism of one degree of freedom necessary for collapse to occur. This mechanism may be specified in terms of the angle change θ of the beam A C D, and the collapsing configuration of the grillage will be as shown in Fig. 6, on page 804, which is drawn looking from the centre of the grillage towards the simple supports. The plastic work done in the hinges is shown in Table I, and the work done by the loads in Table II.

TABLE I.

Hinge.	No.	Angle Change.	Work Done at Hinge.	Total Work Done.
D	8	θ	$M_p\,\theta$	$8\,M_p\,\theta$
E	4	$2\,\theta$	$2\,M_p\,\theta$	$8\,M_p\,\theta$
Total work done at all hinges			.. ..	$16\,M_p\,\theta$

TABLE II.

Load at	No.	Deflection.	Work Done by Load.	Total Work Done.
C	4	$l\,\theta$	$p\,l\,\theta$	$4\,p\,l\,\theta$
D	4	$2\,l\,\theta$	$2\,p\,l\,\theta$	$8\,p\,l\,\theta$
E	1	$4\,l\,\theta$	$4\,p\,l\,\theta$	$4\,p\,l\,\theta$
Total work done by all loads			.. ..	$16\,p\,l\,\theta$

The two expressions for the total work done during the collapse of the grillage may now be equated in order to give the value of p. This assumes that the mechanism chosen was the correct one; if the guess were incorrect, the value of p derived would be greater than that necessary to cause collapse. This method of fixing an upper limit on the value of the collapse load has received considerable attention,* and is a powerful tool in the plastic analysis and design of structures.

* "Limit Design of Beams and Frames," by H. J. Greenberg and W. Prager. *A.S.C.E. Separate No.* 59 (February, 1951); and "Fundamental Propositions in the Plastic Theory of Structures," by M. R. Horne. *Jl. Inst.C.E.*, vol. 39, page 174 (1950).

In this particular example, the mechanism chosen is, in fact, the actual one that will occur; methods are given in the present author's original paper in *Jl. of App. Mechanics*, previously cited, for obtaining both upper and lower bounds on the value of the collapse load, and for narrowing these bounds until the exact solution is obtained. The equation of virtual work then gives

$$p\,l = M_p. \qquad . \quad . \quad (6)$$

This value of p may be checked by a statical analysis as in Fig. 7, on page 804, where it is seen that the fully plastic moment is reached only at the originally assumed hinges, this being an automatic confirmation of the fact that the assumed mechanism is correct. If the analysis of this 3 by 3 beam grillage is undertaken to allow for the effect of the twisting introduced by rigid joints, the collapse load is increased by less than 0·1 per cent. for I-section members (see Appendix); the effect is quite negligible.

TABLE III.—*Single-Beam Grillages.*

—	Grillage No. 1.		Grillage No. 2.	
Strip No. ..	0	0	1	1
Collapse load, lb.	160	155	164	164
Lower yield stress, tons per sq. in. ..	18·4	17·8	17·6	17·6

TABLE IV.—2 BY 2 BEAM GRILLAGES.

—	Grillage No. 3.				Grillage No. 4.			
Strip No.	2	3	4	5	6	7	8	9
Collapse load, lb.	160	174	166	184	172	170	168	166
Lower yield stress, tons per sq. in.	18·8	19·2	19·5	18·7	17·7	17·6	17·8	17·5

TABLE V.—3 *by* 3 *Beam Grillages.*

—	Grillage No. 5.					
Strip No.	10	12	13	15	16	17
Collapse load, lb. ..	160	158	156	152	142	146
Lower yield stress, tons per sq. in. ..	16·9	17·0	17·2	16·6	16·9	16·6

—	Grillage No. 6.					
Strip No.	18	19	20	21	22	23
Collapse load, lb. ..	150	150	152	154	148	148
Lower yield stress, tons per sq. in. ..	17·1	17·3	17·3	17·5	17·4	17·3

Discussion has been confined so far to grillages in which the beams are simply supported at the ends. If the supports are encastred against bending (but neglecting any twisting moments developed) the collapse load is exactly double that of the corresponding simply-supported grillage. No grillages have been tested with more than 3 by 3 beams. It is not difficult, however, to extend the theoretical work to give the collapse loads for grillages consisting of many more beams. From equations (4), (5) and (6), it will be seen that the total loads (P) supported by the 1 by 1, 2 by 2 and 3 by 3 beam grillages are in the ratio 4 : 8 : 9. This series can be continued:

$$4 : 8 : 9 : \frac{32}{3} : \frac{100}{9} : 12 : \frac{49}{4} : \frac{64}{5} : \frac{324}{25}$$

the last figure quoted corresponding to the 9 by 9 beam grillage. If these figures are plotted against the number of beams, two distinct curves can be discerned, corresponding to grillages with an odd and an even number of beams spanning in each direction.

As the number of beams increases, the magnitudes of the rotations at the fully plastic hinges for any one grillage become very disparate; the rotation at one hinge may be as much as five or more times the rotation at a neighbouring hinge. Under these conditions, strain-hardening will set in at the severely strained hinges and will tend to raise the observed value of the collapse load above that computed theoretically. The method outlined can be used to find the collapse loads for rectangular and, indeed, for grillages of any geometrical configuration.

EXPERIMENTAL WORK.

It was decided to check the theoretical results given above by tests on a few simple grillages, in all cases with the ends of the beams simply supported. The technique of using miniature structures was again adopted, owing to the cost and difficulty of conducting full-scale experiments. Some difficulty was encountered in choosing a suitable material; in the first instance, to keep the loads required as small as possible, the possibility of using soft iron or low-carbon steel wire was investigated. However, the properties of such wire were found to vary so much that eventually the beams were made of $\frac{1}{4}$ in. by $\frac{1}{4}$ in. square section. A suitable $\frac{1}{4}$-in. plate of mild steel with good ductile properties was found, and $\frac{1}{4}$-in. strips were mill-sawn from this in lengths of about 2 ft. These strips were turned so that the depths of the beams were measured between the sawn faces, the original surfaces of the plate acting as the sides of the grillage beams. The plate seemed remarkably stress-free, and preliminary tests gave such consistent results that the strips were not heat-treated in any way. This consistency is borne out by the statistical analysis of the beam test results, given below.

In the final tests, experiments were carried out on six specimens; two were single-beam, two 2 by 2 beam and two 3 by 3 beam grillages. After testing the grillages to failure, the component strips were subjected to a four-point beam test in their unyielded portions. This type of beam test has already been described by Professor J. F. Baker and the present author*; in this instance, the simple supports were $4\frac{1}{2}$ in. apart, and the symmetrical concentrated loads were $\frac{1}{2}$ in. apart. Dead loading was applied by means of graduated weights and small quantities of lead shot, weighed as required. Creep occurred in all tests soon after the yield limit was exceeded; the subsequent increments of load were not applied until the increase in deflection in any one minute was less either than 0·001 in. or than 1 per cent. of the total deflection, whichever was the greater. This arbitrary restriction on the creep deflections represents an attempt to provide some measure of controlled conditions in the tests, since it was found that creep might continue steadily for about 10 minutes before sudden and complete collapse occurred. However, the final large increase in deflection in the beam tests was very marked, enabling an accurate estimate to be made of the lower yield stress of the material. A typical load/deflection curve is shown in Fig. 8, on page 804. Tables III to V, herewith, give the collapse loads and corresponding values of lower yield stress for all the beams tested.

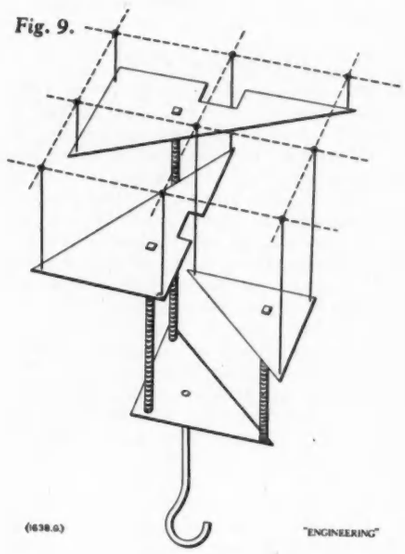
A simple statistical analysis on the values of lower yield stress recorded in the above Tables gives a grand mean of 17·6 tons per square inch with a probable error at the 5 per cent. level of $\pm$ 0·3 ton per square inch, i.e. $\pm$ 1·8 per cent.

The behaviour of each pair of the grillages tested was very similar, and results will be quoted for one only of each type. The distance between the centre lines of the beams was 4 in. in all cases, so that the overall dimensions were 8 in. by 8 in. for

* *Loc. cit.*

PLASTIC DESIGN OF GRILLAGES.

Fig. 9.



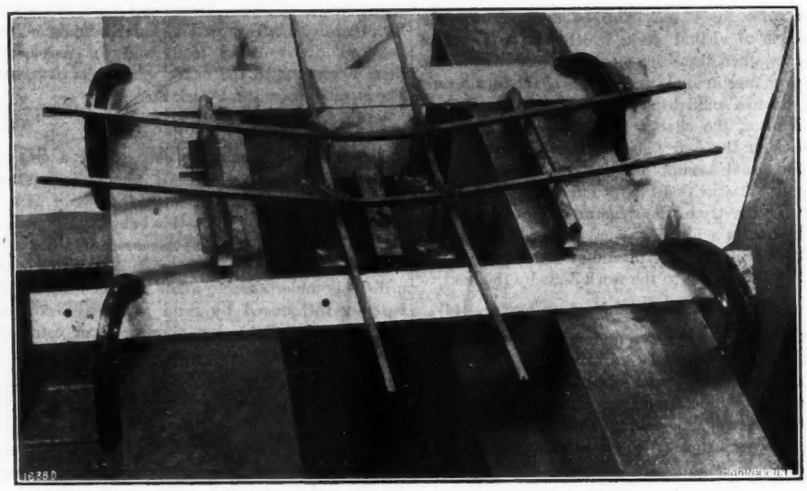


Fig. 10.

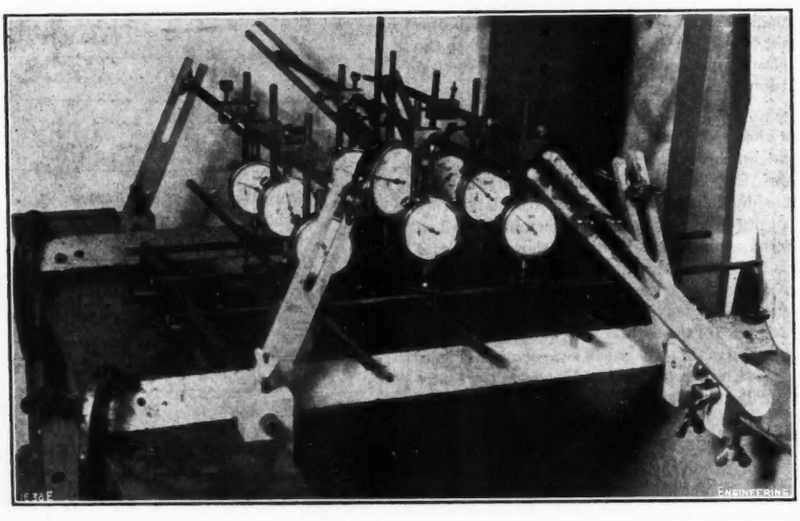


Fig. 11.

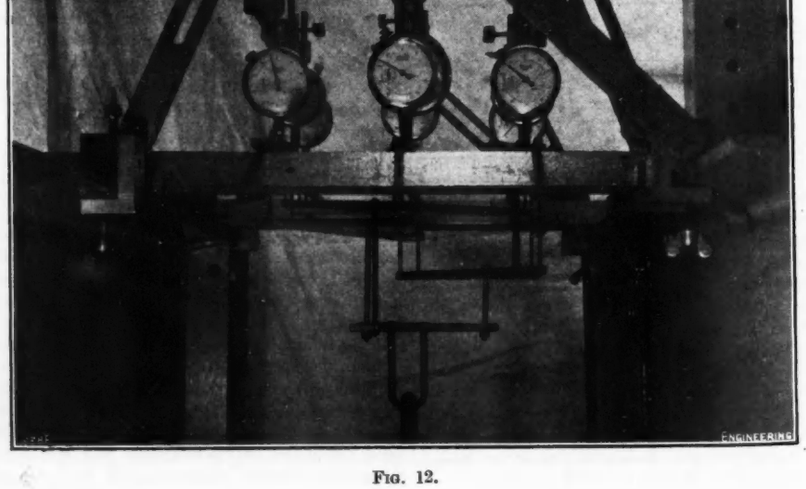


Fig. 12.

the single beam, 12 in. by 12 in. for the two-beam, and 16 in. by 16 in. for the three-beam grillage. Right-angle knife-edge supports were set up at the correct distances, one pair of knife-edges being ¼ in. higher than the other. One set of beams was then placed across the lower supports, and the other set placed across at right angles. The load was applied to the top face of the upper beam by means of a strap, similar to that shown in Fig. 5, on page 804. A hardened steel ball, ¼ in. in diameter, was used to transmit the load through the strap to the grillage; the way in which the straps were placed may be seen in the photograph of the 2 by 2 beam grillage in Fig. 10, herewith; in this illustration the straps at their lower ends form part of a simple, four-point loading linkage. Fig. 11, on this page, shows a 3 by 3 beam grillage under test; the nine loading points were connected in threes to triangular loading plates, as shown in Fig. 12, and schematically in Fig. 9. Rods with balljoints at their ends connected the centres of gravities of the three plates to the apices of a fourth plate, and the single load was applied to the centre of gravity of this fourth plate. The linkage provides, in fact, a means for splitting a single load into nine equal parts. A dial gauge, bearing on the upper faces of the loading straps; was provided at each joint to measure deflections. Load deflection curves for grillages Nos. 2, 4 and 6 are shown in Figs. 13, 14 and 15, on page 807. The theoretical collapse load was calculated from the measured section modulus of the beams of each grillage, using the yield stress of 17·6 tons per square inch given by the mean of the subsequent beam tests.

The test on grillage No. 2 (Fig. 13) was stopped after the final load of 170 lb. had been applied for six minutes. After this time, the deflection of the central joint was still increasing slowly, but there was no marked collapse similar to that observed with the beam tests. For these latter, there is, of course, a central region of the beam where the bending moment is constant. With the single-beam grillage, however, the bending moment increases linearly from the support to the centre, and any large rotation of the joint must be accompanied by some degree of strain-hardening of the material. This effect has been commented upon elsewhere;*

* "Extension of the Simple Plastic Theory to Take Account of the Strain-Hardening Range," by J. W. Roderick and J. Heyman. *Proc. I. Mech.E.*, vol. 165, page 189 (1951).

PLASTIC DESIGN OF GRILLAGES.

Fig. 13. GRILLAGE No. 2.

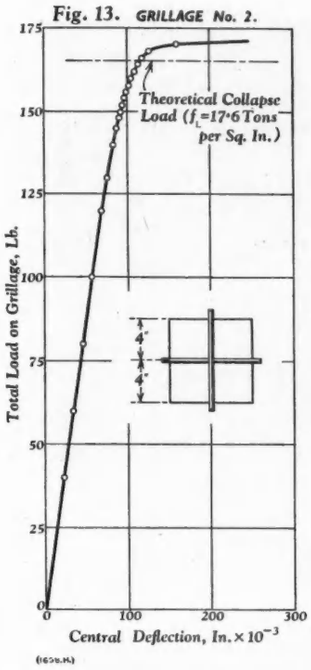


Fig. 14. GRILLAGE No. 4.

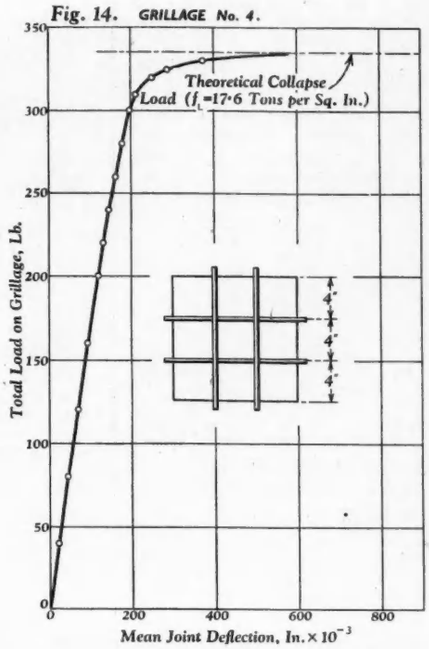
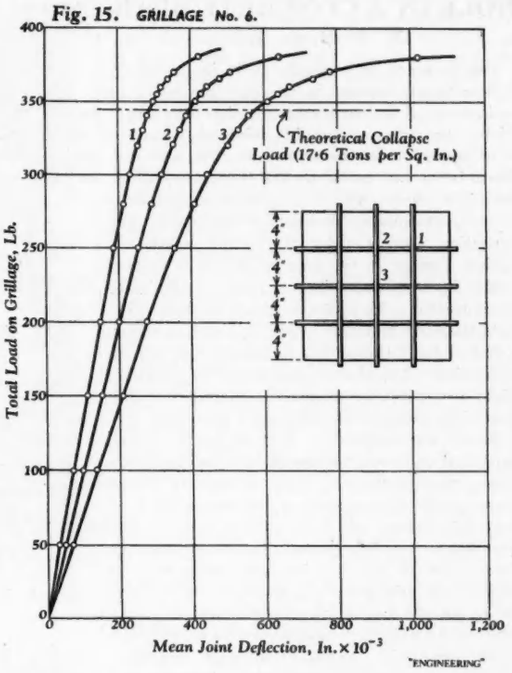


Fig. 15. GRILLAGE No. 6.



the practical result is that the deflections of the grillage are reduced, and that collapse does not occur at a definite load. Instead, the deflections continue to grow, but remain finite with each addition of load. Nevertheless, the observed deflection curve in Fig. 13 indicates that the deflections are becoming large in the region of the predicted collapse load. The test on grillage No. 1 gave results that were almost identical.

Fig. 14 gives the load deflection curve for grillage No. 4, one of the two 2 by 2 beam grillages tested. Owing, apparently, to the fact that the square formed by the beams in the centre of the grillage was subjected to a uniform bending moment, collapse occurred in this instance at the definite load of 335 lb. This value of the load agrees exactly with that calculated. The deflections at the four loading points were in very good agreement, and the single curve shown in Fig. 14 is the mean of the four values.

The effect of strain-hardening is very marked in the curves in Fig. 15 for one of the 3 by 3 beam grillages. The deflections are only just starting to become large in the calculated collapse region, and, as for the single-beam grillage, a definite collapse load was not observed. The deflections at the nine joints were again in good agreement, showing that the nine-point loading linkage behaved satisfactorily; and curves (1) and (2) in Fig. 15 are each the average of four readings. It is of interest to note that the deflections at joints 3, 2 and 1 for the last increment of load were in the ratio 1 : 0·58 : 0·30, compared with the ratio for the theoretical collapse mechanism of $1 : \frac{1}{2} : \frac{1}{4}$. On dismantling the grillage, it was found that each beam had a permanent set at its centre, indicating that a plastic hinge had been formed there, corresponding to the theoretical prediction.

SUMMARY.

The results of the beam tests, though showing some scatter, are statistically very good, the error in the mean value of the lower yield stress being only ± 1·8 per cent.

Summarising the results of the grillage tests, it may be said that they correspond well with the theory given in the first section of this paper. In all cases, the elastic deflections were in almost exact agreement with those given by the normal elastic calculations, and in no case did the deflections become unduly large until the predicted collapse load had been reached or exceeded. The simple plastic hinge theory ignores the effect of strain-hardening, but, from the tests reported here, as for other types of plane structure, it appears that this theory will give a satisfactory design procedure. The use of the equation of virtual work enables trial designs to be checked very quickly, and the correct collapse value determined. Other systems of loading, including combinations of distributed and concentrated loads, give simple terms in this equation, and may be incorporated readily in the theory.

APPENDIX.—COMBINED BENDING AND TORSION OF AN I-BEAM.

It was shown in an earlier article* that the breakdown (or plastic hinge) criterion for a box beam took the form

$$M^2 + \alpha T^2 = M_p^2, \quad . \quad . \quad (7)$$

where M is the bending moment and T the twisting moment to which the section is subjected, and α is a constant of the order of magnitude unity. (In the derivation of equation (7) it was assumed that shear force has no effect on the fully-plastic stress distribution at the hinge.)

The work done by a plastic hinge bending through an angle θ can be shown to be $M_p\,\theta\left(\frac{M_p}{M}\right)$. From equation (7) it is seen that M is always less than M_p, so that the expression for the work done at a hinge is always larger than the corresponding value ($M_p\,\theta$) when the torque is assumed to be zero. The effect is to increase the collapse load of a structure in which the members are capable of sustaining twisting moments, and a 3 by 3 beam grillage, with the ends of the members simply supported, has an increased carrying capacity of up to 10 per cent. if these members are of box form.

An I-section, however, is weak in torsion, and it would be expected that the collapse load of an I-beam grillage will be insignificantly increased if allowance is made for twisting moments. Some estimate of the effect can be derived in the following way:—

Consider first an I-section composed of three equal rectangles of mean dimensions b by t, where b is the breadth and t the thickness of each rectangle. If the section is completely free to warp, the maximum torque that can be imposed can be shown to be equal to

$$T_p = \frac{3}{4} b t^2 q, \quad . \quad . \quad (8)$$

where q is the yield stress in shear. Considering the breakdown condition when the section is subjected to a combination of bending and twisting, and using the criterion of von Mises-Hüber-Hencky, a plastic hinge will be formed when

$$M^2 + \frac{16}{3}\left(\frac{b}{t} + \frac{1}{4}\right)^2 T^2 = M_p^2. \quad . \quad (9)$$

Comparing equation (9) with equation (7), it will be seen that the value of α, as would be expected, is very large when the ratio $\frac{b}{t}$ has a reasonable value of about 10.

Secondly, consider the same I-beam as a member of a grillage, with its ends restrained against warping. It may be shown that the maximum torque that can now be imposed on the beam is of the same order as the value given by equation (8), providing that the length to breadth ratio of the beam is of the same order as $\frac{b}{t}$, i.e., again about 10. Hence, though the value of α will be slightly changed, it will still be large, and the torque that can be imposed will be correspondingly very small. For equal angles of bending and twisting at a hinge, for example, the bending moment M is α times the twisting moment T.

Analysing the 3 by 3 beam grillage, and using equation (7) as the plastic hinge criterion, the collapse load for both free and fixed-ended grillages is increased by approximately $\frac{25}{\alpha}$ per cent.; so that, even with a value of α as low as 250, this increase is only one-tenth of 1 per cent.

* *Jl. of App. Mechanics, loc. cit.*

REINFORCED CIRCULAR HOLE IN A CONCRETE SLAB.

By R. HICKS, B.Sc.

THE presence of a circular hole in an infinite slab uniformly stressed in one direction results in an increase of the stress concentration from one to three. The effect of suitably reinforcing the hole is to control this stress concentration, and it is shown below that as the area of the steel reinforcement in a concrete slab is increased from zero there is an accompanying decrease in the stress concentration until a point is reached where any further increase in the area of the reinforcement results in a corresponding increase in the stress concentration. Examples in practice, where concrete slabs are uniformly stressed in one direction, include a load-bearing wall and a box-type column foundation. A further example where the condition might reasonably be assumed is that of the deck of a bridge designed on monocoque principles.

General expressions are obtained for the radial, tangential and shear stresses in the reinforced slab. These expressions show that the concentration of stress due to the presence of the hole is local, so that the solution can be applied to a finite slab providing its width is several times as great as the diameter of the hole. It is worth noting that, by applying the principle of superposition, this solution can be used to find the stress distribution in a slab subjected to either a pure shear or unequal principal stress distribution around the outer boundary. The latter case is of special interest, because the slab can be compressed without any resulting tension.

The reinforcement is assumed to be distributed so that its bending stiffness in the plane of the slab is negligible. For example, suppose four bars were used to form the reinforcement, then they would be arranged in one column of four one above the other and not, say, in two columns of two. For such a distribution of the reinforcement, it is reasonable to conclude from the work of Reissner and Morduchow[1] and of Gurney[2] that the bending stiffness of the reinforcement in the plane of the slab can be neglected. They considered reinforcements made of the same material as the stressed plate (or slab in the case of concrete) and found that a reinforcement which has a relatively small bending stiffness in the plane of the plate experiences primarily tensile or compressive forces and that its bending stiffness can be neglected—the assumption normally made in theories in reinforced concrete.

The boundary conditions at infinity are the same as those for a similarly loaded slab having an unreinforced hole. That is,

$$(\widehat{rr})_{r=\infty} = \frac{f}{2}(1 + \cos 2\theta). \quad . \quad (1)$$

$$(\widehat{r\theta})_{r=\infty} = -\frac{f}{2}\sin 2\theta, \quad . \quad . \quad (2)$$

where $\widehat{rr}$, $\widehat{r\theta}$ and $\widehat{\theta\theta}$ are the stress components in polar co-ordinates, f is the applied stress, and r, θ the co-ordinates of the point considered.

Around the hole the boundary conditions are obtained by considering an element of the reinforcement subtended by an angle $\delta\theta$, as shown in the diagram. There is assumed to be no shear on a radial cross-section of the reinforcement because its bending stiffness in the plane of the slab is negligible.

For force equilibrium in a radial direction

$$F = a\,h\,(\widehat{rr})_{r=a}. \quad . \quad . \quad (3)$$

where F is the normal force acting on a cross-section of the reinforcement, h is the thickness of the concrete slab, and a the radius of the hole measured to the centre of the reinforcement. Similarly, for force equilibrium in a tangential direction,

$$\frac{dF}{d\theta} = -a\,h\,(\widehat{r\theta})_{r=a} \quad . \quad (4)$$

A further boundary condition is obtained by equating the strain in the reinforcement to the tangential strain in the adjacent part of the slab: thus,

$$\frac{F}{A_R E_R} = \frac{(\widehat{\theta\theta} - \nu\widehat{rr})_{r=a}}{E_C}, \quad . \quad (5)$$

where E_R and E_C are Young's moduli for the reinforcement and concrete, respectively, ν is Poisson's ratio for the concrete, and A_R the cross-sectional area of the reinforcement.

If ϕ is a function which satisfies the equation

$$\left(\frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} + \frac{1}{r^2}\frac{\partial^2}{\partial\theta^2}\right)^2 \phi = 0, \quad . \quad (6)$$

the stresses in the slab are given by

$$\widehat{rr} = \frac{1}{r}\frac{\partial\phi}{\partial r} + \frac{1}{r^2}\frac{\partial^2\phi}{\partial\theta^2}. \quad . \quad . \quad (7)$$

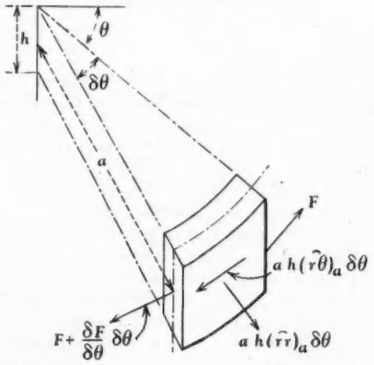
$$\widehat{\theta\theta} = \frac{\partial^2\phi}{\partial r^2}. \quad . \quad . \quad . \quad . \quad (8)$$

$$\widehat{r\theta} = -\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial\phi}{\partial\theta}\right). \quad . \quad . \quad (9)$$

The solution of equation (6) which can be made to satisfy the boundary conditions is

$$\phi = A\log r + Br^2\log r + Cr^2 + D + (A'r^2 + B'r^4 + \frac{C'}{r^2} + D')\cos 2\theta, \quad (10)$$

where A, A', B, etc., are constants.



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Using the value for ϕ given in equation (10), the components of stress become

$$\widehat{rr} = \frac{A}{r^2} + B(1 + 2\log r) + 2C - \left(2A' + \frac{6C'}{r^4} + \frac{4D'}{r^2}\right)\cos 2\theta. \quad (11)$$

$$\widehat{\theta\theta} = -\frac{A}{r^2} + B(3 + 2\log r) + 2C + \left(2A' + 12B'r^2 + \frac{6C'}{r^4}\right)\cos 2\theta. \quad (12)$$

$$\widehat{r\theta} = \left(2A' + 6B'r^2 - \frac{6C'}{r^4} - \frac{2D'}{r^2}\right)\sin 2\theta. \quad (13)$$

The stresses in the slab remain finite as $r \to \infty$, so that the constants B and B' must both be zero. The remaining constants are found by solving the five boundary conditions. These constants are

$$A' = -C = -\frac{4}{f}. \quad . \quad . \quad (14)$$

$$A = \frac{f}{2}\left(\frac{R - 1 - \nu R}{1 + \nu R + R}\right). \quad . \quad (15)$$

$$D' = \frac{fa^2}{2}\left(\frac{R + 1 + \nu R}{3R + 1 + \nu R}\right). \quad . \quad (16)$$

$$C' = \frac{fa^4}{4}\left(\frac{R - 1 - \nu R}{3R + 1 + \nu R}\right). \quad . \quad (17)$$

where

$$R = \frac{A_R E_R}{a\,h\,E_C}.$$

With these values for the constants, the stress components become

$$\widehat{rr} = \frac{f}{2} - \frac{f}{2}\left(\frac{1 + \nu R - R}{1 + \nu R + R}\right)\frac{a^2}{r^2} + \frac{f}{2}\left[1 - 4\left(\frac{1 + \nu R + R}{1 + \nu R + 3R}\right)\frac{a^2}{r^2} + 3\left(\frac{1 + \nu R - R}{3R + 1 + \nu R}\right)\frac{a^4}{r^4}\right]\cos 2\theta. \quad . \quad . \quad (18)$$

$$\widehat{\theta\theta} = \frac{f}{2} + \frac{f}{2}\left(\frac{1 + \nu R - R}{1 + \nu R + R}\right)\frac{a^2}{r^2} - \frac{f}{2}\left[1 + 3\left(\frac{1 + \nu R - R}{3R + 1 + \nu R}\right)\frac{a^4}{r^4}\right]\cos 2\theta. \quad . \quad . \quad (19)$$

$$\widehat{r\theta} = -\frac{f}{2}\left[1 + 2\left(\frac{1 + \nu R + R}{1 + \nu R + 3R}\right)\frac{a^2}{r^2} - 3\left(\frac{1 + \nu R - R}{1 + \nu R + 3R}\right)\frac{a^4}{r^4}\right]\sin 2\theta. \quad (20)$$

When r becomes several times greater than a, the terms containing $\left(\frac{a}{r}\right)^2$ and $\left(\frac{a}{r}\right)^4$ can be neglected and the stress components reduce to

$$\widehat{rr} = \frac{f}{2}(1 + \cos 2\theta). \quad . \quad (21)$$

$$\widehat{\theta\theta} = \frac{f}{2}(1 - \cos 2\theta). \quad . \quad (22)$$

$$\widehat{r\theta} = -\frac{f}{2}\sin 2\theta. \quad . \quad . \quad (23)$$

The effect of the hole is, therefore, local and for this reason the solution can be applied to a finite slab providing its width is several times greater than the diameter of the hole. When R = 0, expressions (18), (19) and (20) give the stress components for the case of an unreinforced hole.

Around the hole, where $r = a$, the expressions for the stress components become

$$(\widehat{rr})_{r=a} = \frac{fR}{1 + \nu R + R} - \frac{2fR\cos 2\theta}{3R + 1 + \nu R}. \quad . \quad (24)$$

$$(\widehat{\theta\theta})_{r=a} = \frac{f(1 + \nu R)}{1 + \nu R + R} - \frac{2f(1 + \nu R)}{3R + 1 + \nu R}\cos 2\theta. \quad (25)$$

$$(\widehat{r\theta})_{r=a} = \frac{-4fR\sin 2\theta}{3R + 1 + \nu R}. \quad . \quad (26)$$

When there is no reinforcement, the maximum stress acts in a tangential direction on the boundary of the hole and equals $3f$. This maximum stress decreases as the area of the reinforcement increases from zero. It can be shown graphically that the area of the reinforcement can be increased with a corresponding decrease in the maximum stress, until a point is reached where the maximum tangential stress equals the maximum shear stress. Any increase in the area of the reinforcement above this value results in a corresponding increase in the maximum stress in the slab. There is, therefore, an area of reinforcement which corresponds to a minimum value for the maximum stress which can occur in the slab. From equations (24) and (25), the area of the reinforcement necessary to make the maximum stress a minimum can be obtained from the equation

$$\frac{4R}{3R + 1 + \nu} = \frac{1 + \nu R}{1 + \nu R + R} + \frac{2(1 + \nu R)}{3R + 1 + \nu R},$$

which gives

$$A_R = \frac{a\,h\,E_C}{E_R} \times \left[\frac{(1 + 6\nu) + \sqrt{(1 + 6\nu)^2 + 12(4 - \nu - 3\nu^2)}}{2(4 - \nu - 3\nu^2)}\right]. \quad . \quad (27)$$

Regardless of whether the maximum stress in the plate is to be a minimum or not, for a plate and

CONTINUOUS CASTING OF COPPER INGOTS.

SHEPPARD AND SONS, LTD., BRIDGEND.

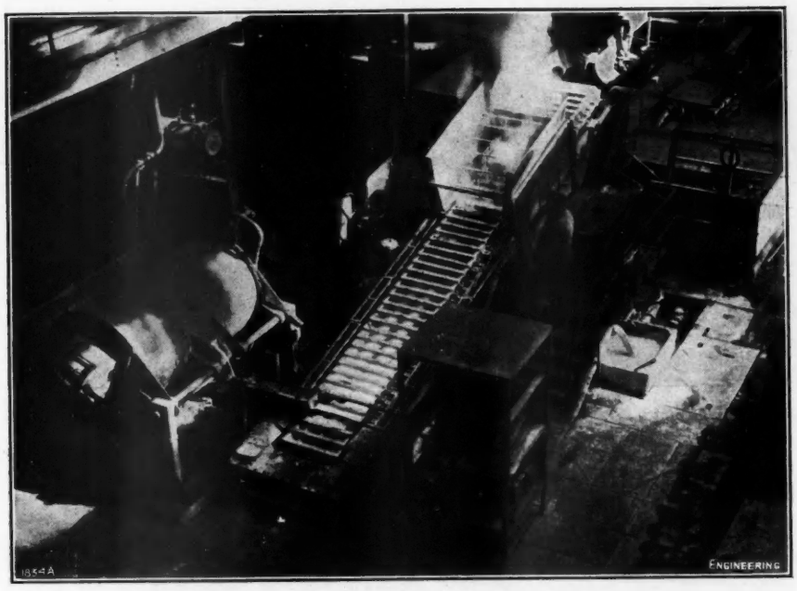


FIG. 1. CASTING END.

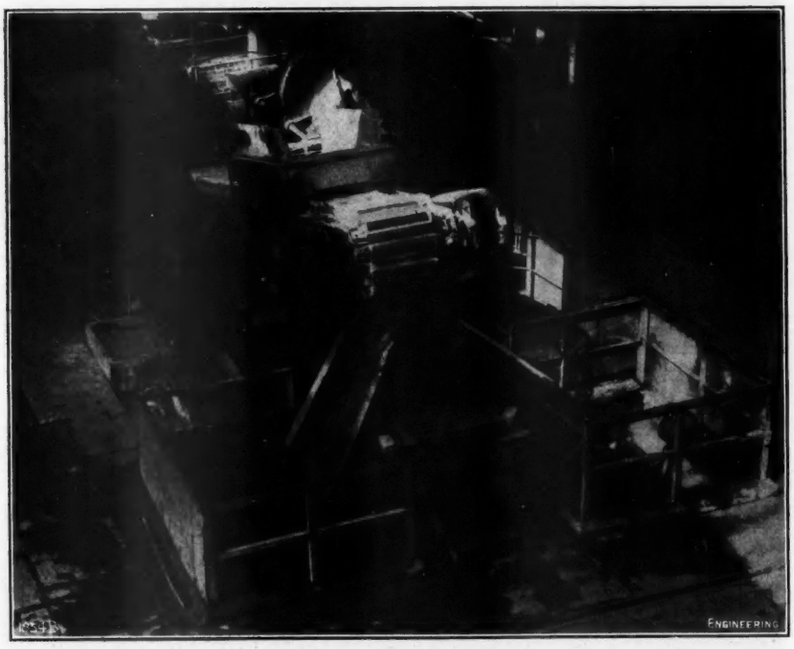


FIG. 2. PIG-DISCHARGING END.

reinforcement of a given size the stress components are given by expressions (18), (19) and (20). For any practical value of ν, the bracket term in equation (27) does not differ appreciably from unity, and for design purposes can be taken as such. Furthermore, the amount of reinforcement normally regarded as sufficient in practice is less than that required to reduce the maximum stress in the slab to a minimum.

REFERENCES.

[1] H. Reissner and M. Morduchow, "Reinforced Circular Cut-outs in Plane Sheets." *N.A.C.A. Technical Note* No. 1852, April, 1949.

[2] C. Gurney, "An Analysis of the Stresses in a Flat Plate with a Reinforced Circular Hole under Edge Forces." *Aero. Research Council Reports and Memoranda No.* 1834, 1938.

CONTINUOUS CASTING MACHINE FOR COPPER INGOTS.

THE machine shown in the accompanying illustrations has been designed and built by Sheppard and Sons, Limited, Bridgend, Glamorganshire, to meet the requirements of Imperial Chemical Industries, Limited, Metals Division, Landore Works, Swansea. It is a single-strand static-type machine, which in basic principle is similar to others in the range manufactured by Sheppard and Sons, Limited, for a variety of duties. The machine is designed to operate in conjunction with an oil-fired holding ladle of 5 tons capacity, which is charged by ladle and overhead electric crane from adjacent copper-refining furnaces. The casting machine is capable of producing notched copper ingots or pigs up to 56 lb. each at a rate of 15 tons per hour. It occupies a floor space of 25 ft. by 10 ft., and has an overall height of 8 ft. 10½ in.

Basically, the machine consists of an endless chain conveyor on which are mounted ingot moulds of suitable size and shape. Molten metal is poured into the moulds at one end of the machine, and as the moulds move slowly away from the pouring point the metal solidifies. At the other end of the machine, the solid ingots fall from the moulds as the latter are inverted to return along the lower part of the conveyor. As the moulds return to the pouring point they are sprayed automatically with a dressing compound, ready to receive molten metal once more. The solidification or freezing of the metal in the moulds is accelerated by a cold-water spray.

The machine has a built-up conveyor consisting of two flat chains carried on cast-iron flanged rollers running on a rolled-steel angle track, which slopes upwards (as shown in Fig. 1) from the pouring end to the drive head, at which point the solid ingots are discharged. Bolted to the conveyor chain are 100 moulds, which are provided with lips on their rear edges; these ensure that metal from an overfilled mould is passed on to the following one. Screw-type tension gear is provided at the pouring end of the conveyor.

At the drive end the conveyor passes over octagonal driving wheels, which are mounted on a drive shaft carried in bearings on a steel framework. The drive is from a 5-h.p. squirrel-cage electric motor taking current at 520 volts, 3 phase, 50 cycles, and running at 1,425 r.p.m. This drives, through a flexible coupling, a Carter hydraulic infinitely-variable gear having a speed range of 1,385 to 280 r.p.m., with an input speed of 1,425 r.p.m. The output shaft of the Carter gear is coupled through a second flexible coupling to a Moss worm gearbox having a ratio of 60 to 1. A Morse triple roller chain of 1-in. pitch takes the drive from the worm gearbox to a countershaft at the drive head. The final drive is by machine-cut gearing, a brass shear pin being incorporated in the final spur wheel.

By means of the Carter gear it is possible to vary the speed of the mould conveyor, and thus obtain a solidifying time cycle which covers the range of temperatures. This speed variation is used to compensate for the fact that at the beginning of a casting run the moulds are colder, and the ingot solidifying time consequently shorter, than when the machine has been running for some time, and the moulds have acquired their normal working temperature.

At the drive head of the machine the moulds are inverted as they pass over the drive shaft, and the solid ingots fall from them by gravity. A mechanical tapping apparatus is provided to assist the discharge of the ingots from the moulds. It consists of a pivoted hammer, to which is connected a counterweight. A cam mounted on the drive shaft moves the hammer away from the mould which is turning over the head of the machine, and then releases it suddenly, when the counterweight causes it to swing upwards and strike the mould a sharp blow. The tapping hammer is visible in Fig. 2, just above the left-hand discharge chute.

As the ingots fall from the moulds, they are received by a divided chute, which has a hand-operated diverting flap to direct them into one of two five-ton skips, which are immersed in water in concrete cooling boshes. As one skip is filled, an operator swings over the diverting flap, to start filling the second skip, and the first one is lifted from the bosh by an overhead electric crane. The skip is taken to the end of the shop, where it is tipped to discharge the ingots. In Fig. 2, the diverting flap is set for the right-hand skip, which is nearly full.

The solidification of the ingots as they travel along the mould conveyor is accelerated by a cold-water spray, which is visible in Fig. 1. Individual control is provided for each of the spray pipes so that the cooling rate can be adjusted as required. Cooling water is drawn from the works main. It is collected by a drain tray under the mould conveyor, and run to waste after use.

As the moulds pass along the underside of the conveyor to return to the pouring point, they are sprayed automatically with a dressing liquid.

They are still hot at the point where the liquid is applied, and the dressing is thus dried out ready to receive molten metal by the time the pouring end is reached. As the mould-dressing liquid settles easily, compressed air at 80 lb. per square inch, from the shop air line, is blown through the liquid in the tank which is visible in the right foreground of Fig. 1. From the tank the dressing liquid is drawn by an electrically-driven unchokeable pump made by Lee Howl and Company, Limited, Tipton, and forced through rose nozzles under the line of moulds. A drain tray catches the surplus liquid and returns it to the storage tank. Provision is made for clean water to be circulated by the pump to flush out the piping after the conclusion of a casting run.

Control of the machine is in the hands of an operator seated in a small cabin at the pouring end (Fig. 1). A second operator, visible in both illustrations, controls the cooling-water supply and the mould spray gear. The operator at the pouring end is provided with foot switches to control the casting machine motor and the holding-ladle tilting gear, and with a hand-controlled casting launder. The holding ladle is of the lip-axis tilting type, and is tilted by an electrically-driven winch mounted above it. The ladle tilting gear can be seen in Fig. 1. The operator controls the rate of pouring from the ladle by means of the tilting gear, and directs the flow of metal into the moulds with the casting launder. Normally, the casting machine is stopped and started by the operator in the cabin as required, but emergency push-button switches are provided at the end and side of the machine.

Lubrication of the conveyor chain and rollers, which work under hot conditions, is by "Dag" colloidal graphite supplied by Acheson Colloids, Limited, and the remainder of the moving parts of the machine are provided with grease nipples, which are grouped into easily accessible positions.

SMITHFIELD SHOW AND AGRICULTURAL MACHINERY EXHIBITION.

(*Concluded from page* 791.)

Tractor-Hauled Combine Harvester.

Considerable progress has been made during recent years in the development of tractor-hauled combine harvesters and several models suitable for use behind standard farm tractors are now made. A good example is furnished by the Marshall 626 machine which was shown by the manufacturers, Marshall, Sons and Company, Limited, Gainsborough. This unit is illustrated in Fig. 14, where it is shown at work behind a "Field-Marshall" 40-h.p. Diesel tractor.

The 626 combine has a cutting width of 6 ft., a gathering width of 6 ft. 7 in. and a cutting range of from 2 in. to 20 in. The crop is fed on to the cutter bar by a four-bladed reel arranged so that it can be adjusted both horizontally and vertically. After it is cut, the crop is directed to a central 3-ft. wide canvas conveyor by two horizontal augers disposed one at each side. The central canvas delivers the crop to a chain-and-rake elevator which, in turn, feeds the beater. The 3-ft. wide 18-in. diameter threshing drum is fitted with eight ribbed-type beater bars and works in conjunction with a wired-type concave having ten bars. The straw is stripped from the drum by a further beater which subsequently directs it to the straw shakers. There are four box-type shakers and these reciprocate on double cranks in much the same manner as in the manufacturers' stationary machine. To ensure efficient dressing of the grain, an exceptionally large cavings riddle is used; this measures 3 ft. 6 in. by 2 ft. 8 in. and is provided with longitudinal ribs to counteract any tendency of the grain to fall to one side when the combine is operating on lateral slopes. On leaving the cavings riddle, the grain is directed by an inclined tray to the forward end of the dressing riddle. Five riddles with perforations varying from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. are available, and, like the cavings riddle, they are divided into four sections by longitudinal ribs.

After passing through the dressing riddle the grain is directed by an auger to an elevator which feeds it to an adjustable rotary-type grading screen fitted with a spring-loaded brush. This separates out the dust, seeds and small grain, and on the bagging platform there are two spouts for best-quality grain and a third spout for seeds, dust, etc. The air blast to the cavings and dressing riddles is

EXHIBITS AT THE SMITHFIELD SHOW.

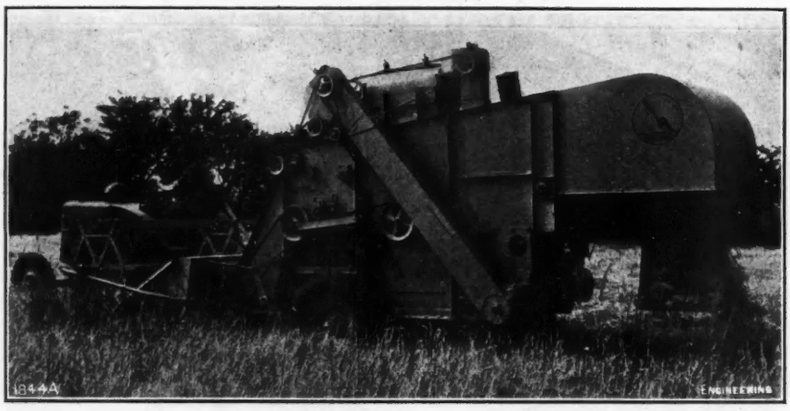
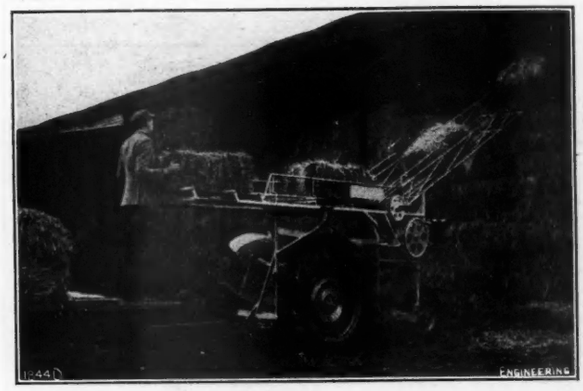


Fig. 14. Tractor-Hauled Combine Harvester.

Fig. 15. Reversible Disc Plough.

Fig. 16. Stalk and Weed Shredder.

EXHIBITS AT THE SMITHFIELD SHOW.



FIGS. 17 AND 18. DUAL-PURPOSE LOADER AND STACKER.

FIG. 19. HALF-TRACK CONVERSION SET FOR TRACTORS.

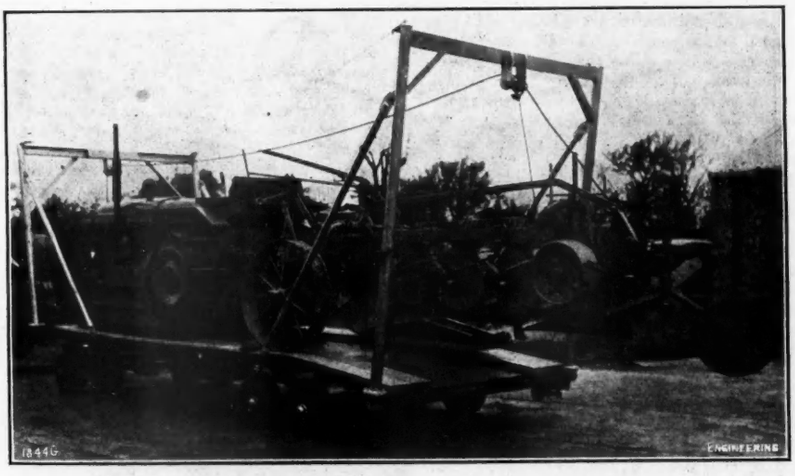


FIG. 20. 7-TON SHORT-HAUL TRAILER.

provided by a five-bladed fan, the amount of air delivered to the riddles being adjustable. The complete machine is driven by a Ford industrial petrol engine developing 20 h.p. at a governed speed of 2,250 r.p.m.

REVERSIBLE DISC PLOUGH.

Several new items of equipment were shown by Ransomes, Sims and Jefferies, Limited, Ipswich. These included a three-furrow tractor-mounted disc plough of compact design. This implement is illustrated in Fig. 15, where it is shown attached to the rear implement linkage of a Nuffield universal tractor. The reversing mechanism is quite straightforward and, although it is manually operated by a lever from the driving position, the movement entails little effort due to the extensive use of ball bearings in the moving parts. The reversing lever is attached directly to an arm on the stem, or standard, of the centre disc which, during reversing, merely pivots about its standard. The standards for the front and rear discs, however, are carried at the ends of swinging links which, in turn, are connected through a suitable linkage to an arm on the central standard so that, when the reversing arm is operated, the central disc pivots about its standard and, in so doing, causes the leading and trailing discs to swing through arcs in the horizontal plane thus bringing the discs into the correct relative positions appropriate to the direction of travel.

The discs are made from high-grade manganese steel and have a diameter of 26 in. They are heat-treated so that the centre is left ductile to withstand shock loadings, but the outer edge is toughened to resist wear. Taper-roller bearings are fitted to the centre of each disc, arranged so that any slackness which may develop after long service can be taken up. The bearings are sealed to prevent entry of mud, grit, etc., and are packed with lubricant. To suit different soil conditions, the angle of the discs can be varied, thus altering the overall width of the plough. For hard conditions, for example, the discs can be set to give a total cut of 24 in., whereas for easy going the width can be increased to 30 in. These adjustments are governed by a simple bracket having stops of different sizes and can be made in a matter of minutes.

The plough is lowered into the work by means of the hydraulically-operated tractor implement-lift assembly. Depth of working is set by an adjusting screw fitted to the rear wheel and the plough is levelled by altering the length of the top link of the three-point linkage. Special attention has been paid to the design of the rear wheel to eliminate any tendency for it to kick out of the furrow when the discs encounter hard patches. The wheel itself is fitted with roller bearings and is formed from three parts, namely, a knife-edge tyre sandwiched between two discs. Wheel track is adjusted by a series of holes formed in a tiller bar fitted to the top of the wheel stem. The complete plough weighs 1,030 lb. and is intended for use with medium-power tractors such as the Fordson Major and Nuffield Universal. Extra equipment available for use with the plough includes scrapers for the discs and earth shields to prevent wear of the disc brackets.

STALK AND WEED SHREDDER.

The exhibits on the stand of Steel Fabricators (Cardiff), Limited, Roath, Cardiff, included an interesting new machine designed to disintegrate standing stalks and weeds. This machine, which is known as the Horndraulic shredder, is illustrated in Fig. 16, where it is shown destroying standing bracken.

It consists of three shredding units, the design of which resembles that of a hammer-mill rotor in that each consists of a number of swinging hammers arranged about a centre shaft. The axes of the shafts lie along the direction of travel; the two outer shafts each have six hammers and the centre shaft has four hammers. The machine is driven from the tractor rear power take-off through an

adjustable shaft fitted with universal joints. This drives the centre shaft at the speed of the tractor power take-off and the two outer shafts are driven from the centre shaft by V-belts. These shafts, however, rotate at more than twice the speed of the centre shaft. The swinging hammers are joined to their respective shafts through rubber bushes and the hammers are designed so that they can be reversed. The distance between the two outside shafts is 38½ in. and the inside width of the hood is 58 in. The height of the shredding units can be adjusted from ground level to a maximum of 11 in. above the ground by means of a hand lever.

Dual-Purpose Loader and Stacker.

Steel Fabricators (Cardiff), Limited, were also showing the loading and stacking machine illustrated in Figs. 17 and 18, on page 811. It is known as the Brinkworth loader and, as shown in the two illustrations, it can be used for loading bales, sacks, etc., from the ground to a trailer and then elevating them to the top of a rick, dutch barn, loft, etc. It can be installed on any tractor or can be used independently, being provided with its own power unit.

Basically, the loader consists of two main parts—a tubular-steel stationary structure, bolted to the side of the tractor, to which is pivoted a movable tubular-steel structure or arm. This latter structure forms the elevator which is raised and lowered by means of a hydraulic jack connected into the hydraulic system of the tractor. Both the stationary structure and the elevator are fitted with chain-type conveyors, which are driven by a single-cylinder air-cooled Villiers petrol engine. The drive is transmitted to the two conveyors through V-belts and a reversing gearbox so that the role of the loader can be changed in a moment. Although the illustration shows it installed on a tractor, it can, of course, be used with equal facility on trucks and lorries. The maximum height to which bales, etc., can be raised depends on the basic vehicle to which it is fitted and varies between 16 ft. and 20 ft.

Half-Track Conversion Set for Tractors.

The exhibits on the stand of J. C. Bamford, Limited, Uttoxeter, Staffordshire, included equipment for converting a standard wheeled tractor into a half-track machine. Sets are made for use with several tractors, such as the Ferguson, Fordson, Nuffield and David Brown. Fig. 19, on page 811, shows a standard Fordson tractor so equipped. This illustration also shows the tractor fitted with skis in place of the front wheels for operation in snowy conditions.

The tracks are of simple design, each consisting of two rubber-and-canvas endless belts joined to each other by steel track plates which span the wheels. The track plates are bolted to the belts and are drilled with holes at varying centres so that several sizes of wheel can be catered for by one set of tracks. The idler wheels are each fitted to the ends of tubular-steel arms, one for each idler. These arms extend forwards from the tractor rear axle and are pivoted thereto through hardened-steel pins. The forward ends of the arms are supported by a transverse leaf spring which passes underneath the tractor. As will be seen from the illustration, the idler wheels are fitted with pneumatic tyres. The tracks are easy to fit and it is claimed that they can be removed in approximately two minutes.

7-Ton Short-Haul Trailer.

The special-purpose trailers exhibited by the Low Loading Trailer Company, Limited, Bedford, included that shown in Fig. 20, on page 811. Known as the Lolode 7-ton short-haul trailer, it has been designed for use on moderately short journies of up to, say, 20 miles. It is unsprung, and to obtain the lowest possible platform height it is fitted with 18 × 7 eight-ply tyres. The mean loading height obtained by this means is only 1 ft. 11 in., and this, combined with the downswept rear end and detachable ramps, facilitates the loading of "live" and "dead" tractors, etc.

There are, in all, eight wheels, disposed equally at the front and rear, the rear wheels being fitted to side beams which are free to rock longitudinally about a tubular cross-member, and the front wheels in pairs to a tubular front axle, each pair of wheels being free to rock laterally. The front axle is connected to the trailer chassis by a tubular steering head, the spindle of which is 3 in. in diameter and is made from 40-ton steel. The towbar is a high-tensile steel forging and is suitable for coupling to a tractor towing jaw or hoor. It incorporates an over-run brake unit designed to operate 12-in. diameter internal-expanding brakes fitted to each

EXHIBITS AT THE SMITHFIELD SHOW.

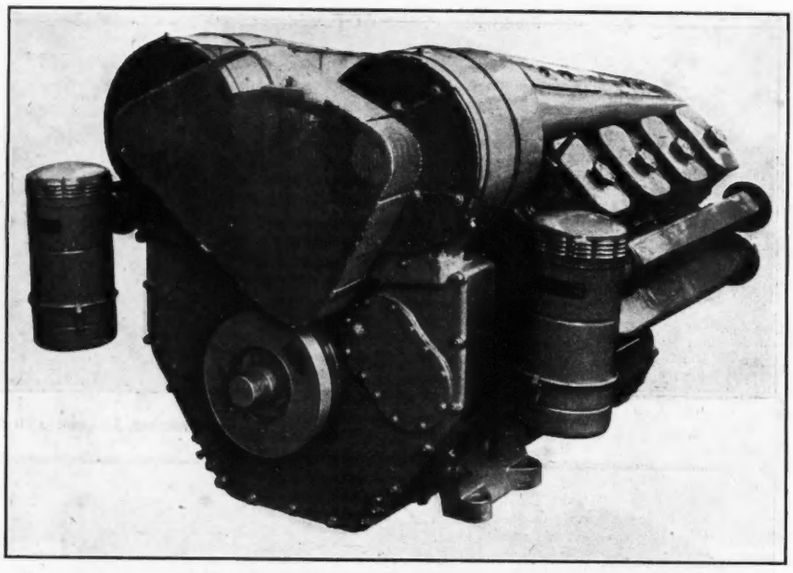


Fig. 21. Eight-Cylinder Diesel Engine.

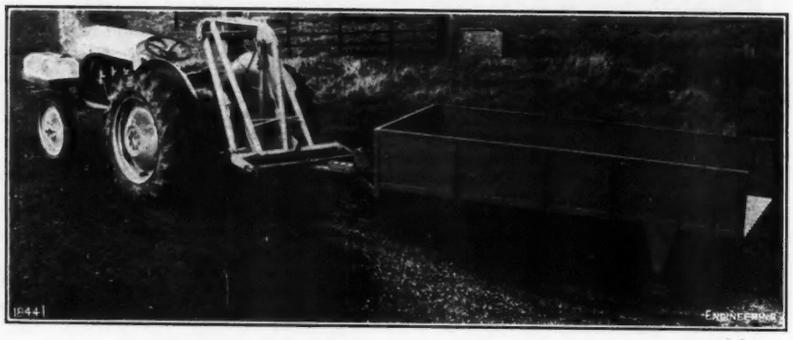


Fig. 22. General-Purpose Trailer.

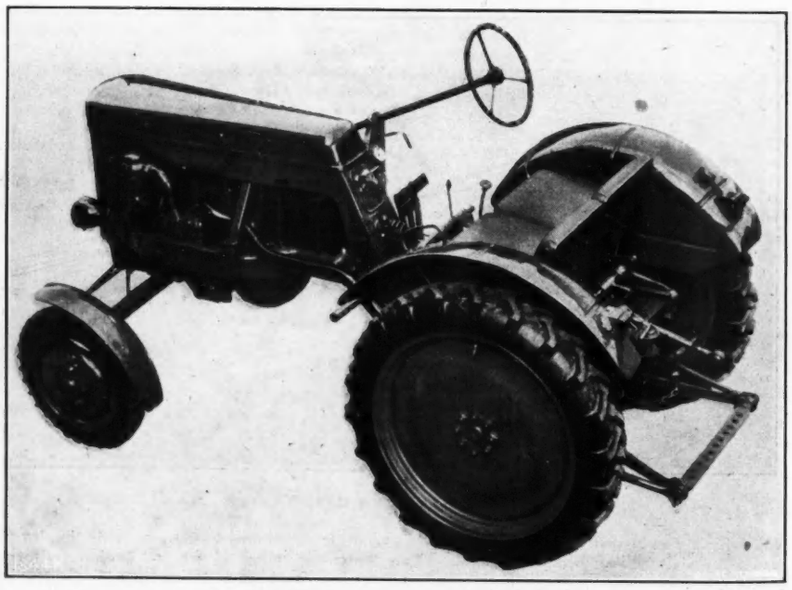


Fig. 23. Light Diesel Tractor.

LORRY-MOUNTED TOWER CRANE.

STEELS ENGINEERING PRODUCTS, LTD., SUNDERLAND.

of the four front wheels. A hand parking brake is mounted on the towbar, together with a reversing stop. The deck of the trailer consists of 1½-in. thick hardboards. Extra equipment available for use with the trailer includes a 2-ton winch and the implement supporting frame shown in the illustration.

EIGHT-CYLINDER DIESEL ENGINE.

Petters, Limited, Staines, Middlesex, showed a modified version of their V-type eight-cylinder air-cooled Diesel engine. This engine was introduced at last year's Public Works Exhibition and was described in ENGINEERING, vol. 174, page 626 (1952). The latest version, which is now known as the PDV8, is shown in Fig. 21, on page 812. The main difference between this engine and its predecessor, namely, the PBV8, is an increase of the bore to 4¼ in., the stroke remaining at 4·33 in. The power rating at 1,500 r.p.m. remains the same, that is, 80 brake horse-power; thus the rating is more conservative than previously. Another important difference between this engine and its predecessor is that the cooling air for the cylinders, cylinder heads, etc., is now supplied by two axial-flow fans instead of a single fan. As will be seen from the illustration, the two fans are arranged at the timing-case end of the machine, thus making the unit suitable for automotive applications. Both fans are driven through multiple V-belts from the same pulley, which, to keep the belts as short as practicable, is mounted as high as possible on the timing-gear case. This new configuration reduces the overall height of the engine, as well as reducing the size and vulnerability of the cylinder cowlings. In most other respects, the new and old engines are similar. Notable features of the design are the use of chromium-plated top-compression piston rings; the fitting of offset cylinders to permit side-by-side mounting of the connecting rods; the use of through bolts for retention of the cylinders and cylinder heads; variable governing between the limits of 1,000 r.p.m. and 1,800 r.p.m.; and the excellent accessibility. The maximum output of this engine is 96 brake horse-power at 1,800 r.p.m. on the 12-hour rating.

GENERAL-PURPOSE TRAILER.

In addition to the air compressor described on page 791, *ante*, Maxim Engineering, Limited, Charvil Works Bath-road, Twyford, Berkshire, also showed the trailer illustrated in Fig. 22. This trailer is of more than usual interest in that it has been designed primarily for use with the "Rearloda," a hydraulic loader, designed and manufactured by H. Cameron Gardner, Limited, Woodley Aerodrome, Reading, Berkshire.

As its name suggests, the Rearloda is installed at the rear of a tractor and normally is used for loading various materials into trailers, etc. By hitching the towing eye of the trailer to the free end of the loader, it is possible to convert it into a tipping trailer, operation of the loader causing the front end of the trailer to be raised. Another feature of the trailer is its unusual narrowness, the width being only 3 ft. 8 in., which permits it to be manœuvred through doors and openings as narrow as 4 ft. A castor wheel fitted to the drawbar can be folded away when not required. The interior dimensions of the body are 3 ft. 4 in. by 9 ft. by 1 ft. 6 in. high, and the overall length, including the drawbar, is 12 ft. The weight with full equipment is 5 cwt. and the maximum capacity is 30 cwt. on twin wheels and 16 cwt. on single wheels.

LIGHT DIESEL TRACTOR.

The exhibits on the stand of H. L. Arnes and Company (Engineering), Limited, Morley House, 314-320, Regent-street, London, W.1, included a new light tractor manufactured by Hanomag, Hanover. This machine, which is known as the Hanomag Combitrac, is illustrated in Fig. 23. Outstanding features of the design are the use of an exceptionally narrow engine cowling, thus giving excellent vision for row-crop work, and the fitting of a single-cylinder two-stroke Diesel engine. The engine has a bore and stroke of 85 mm. and 90 mm., respectively, and is capable of a continuous output of 12 h.p. There are six speeds, giving rates of travel ranging from just under 1 mile an hour to nearly 12 miles an hour. A creeping-speed gear can be fitted if required, enabling the speed of the tractor to be reduced to 0·19 miles an hour at half the maximum engine speed. Standard equipment supplied with the tractor includes electric starting and lighting and a differential lock. The extra equipment available covers, in addition to the creeping-speed reduction gear, such items as a belt-pulley power take-off, hydraulic implement lifts, etc.

LORRY-MOUNTED TOWER CRANE.

THE tower crane shown in the accompanying illustration was demonstrated recently before representatives of the building industry and civil engineering and public works contractors at the Crown Works of Steels Engineering Products, Limited, Sunderland. It is one of the range of Coles cranes which this company manufactures. The advantage of tower cranes depends primarily upon the height of the tower, which permits the operator to see exactly where the load is being placed; this applies particularly to work on multi-storey buildings The tower of the crane can be lowered to give a clearance height of 22 ft. 9 in. when the vehicle is travelling over long distances. In addition, it can be removed and replaced by a jib; this conversion was carried out during the demonstration in 58 minutes.

The chassis upon which the crane is mounted has two front wheels and four twin rear wheels and the drive is provided by a Leyland engine. Stabilising arms, which can be seen projecting from beneath the chassis in the illustration, give added support to the vehicle when the crane is in use. Individual electric motors drive the hoist, derricking and slewing gear. The power for the motors is taken from a generator, which can be supplied with Diesel or petrol-engine drive. The power units for the crane are all housed in a covered compartment at its base. The model demonstrated was fitted with a 60-ft. tubular jib and was capable of lifting 5 tons at a radius of 24 ft. to a height of 82 ft. 6 in. above the ground level. It will raise 2 tons at 42-ft. radius to 71 ft. 6 in., and hoisting speeds of 120 ft. per minute can be achieved when raising a load of 1 ton.

The crane operator's cabin is placed above the pivot of the jib, which is 36 ft. above ground and to which access is gained by a steel ladder attached to the main superstructure; this leads on to a small platform alongside the cabin. The whole crane can be driven about the site with the tower erected, and, as previously mentioned, the tower can be lowered under power to a convenient height for longer journeys, and also to ground level for dismantling. The jib of the crane can be derricked from its maximum radius to minimum radius in 90 seconds. Safety devices are fitted to ensure that the hoisting and derricking gear are not used beyond specified limits and electromagnetic brakes prevent any movement taking place if the supply of current fails. A safe-load indicator can also be fitted as extra equipment.

THE LATE MR. F. HARTT.—We note with regret the death of Mr. Frank Hartt, which occurred on December 3 after a short illness. Mr. Hartt, who was 66 years of age, was a senior sales representative of J. Stone & Co. (Charlton), Ltd., Woolwich-road, Charlton, London, S.E.7. He was responsible for much pioneer work over a long period of years, principally in the application of aluminum and magnesium-alloy castings in the aircraft industry.

HISTORY OF AN ELECTRICAL FIRM.—The International General Electric Co. of New York, Ltd., have sent us a handsomely illustrated booklet, entitled "A General Electric Scrapbook History." It is described as a fantasy in spirit but is in fact an expression of that well-known undertaking's first 75 years of growth. It is fittingly linked up with the personages who contributed to that growth, including Edison, Brush, F. J. Sprague, Elihu Thomson, Houston and C. P. Steinmetz. There are many illustrations of historic documents and occasions and much information about the development of the firm.

TRAINING FOR PRODUCTION: ADDENDA.—In a leading article on page 689, *ante*, dealing with a report on production management in the United States, reference was made to the fact that the author of the report, Mr. H. C. Wiltshire, M.I.I.A., had visited American establishments as the result of a travelling scholarship. The Institute of Industrial Administration have asked us to point out that Mr. Wiltshire went to the United States as the winner of the Walter Hines Page travelling scholarship, 1952, which was awarded by the Institute and the English Speaking Union for the purpose of studying and reporting on the teaching of work study in the United States and the use made of work study in American industry.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

SCOTTISH IRON AND STEEL INDUSTRY.—Steel production was well maintained in the Scottish district during November, the annual rate of 2,410,800 tons comparing with 2,407,500 tons in October and 2,327,400 tons in November, 1952. Although scrap deliveries have been much improved recently, pig-iron outputs have had to be held at a high level because of the expansion in steel production. The annual equivalent output from the nine blast-furnaces in operation during November was 872,700 tons, against 877,100 tons in October, and 851,500 tons in November of last year.

IMPORT-EXPORT OF COAL.—The first shipment of coal to Scotland this winter, from overseas, arrived in the collier Duiveland at Leith December 8. The cargo consisted of 1,200 tons of large coal from the Saar and had been loaded at Rotterdam. After discharging her cargo the Duiveland proceeded to Methil, where she took on a corresponding tonnage of industrial smalls for unloading at Rotterdam and transhipment by barge to southern Germany.

PROPOSAL TO ELECTRIFY HIGHLAND RAILWAY LINES.—After a conference in Inverness on December 11 between representatives of the British Transport Commission and members of Inverness County Council, Mr. T. F. Cameron, chief regional manager, British Railways (Scottish Region), told the Council deputation that, in present circumstances, the electrification of railway lines in the Highlands could not be given any high priority in view of the other commitments of the Transport Commission. A change-over from coal to electricity had been suggested by the Council, which had received from the North of Scotland Hydro-Electric Board a memorandum giving 8,000,000*l.* as the estimated cost of converting the 114 miles of line between Inverness and Perth. The figure included the provision of locomotives.

MOUSWALD RADIO TRANSMITTER.—A new 2-kW transmitter, part of the British Broadcasting Corporation's plan to make local improvements in the coverage of the Home Service, went into operation on December 13 at Mouswald, near Dumfries. The new station, which took over from a temporary transmitter on the same site, is radiating on 371 m.

RECONSTRUCTION OF ARMADALE PIER.—A scheme for the reconstruction of Armadale Pier, Skye, is to be submitted to the local District Council for consideration. The cost is estimated to be 67,500*l.*, of which 16,875*l.* has to be met locally.

WHITEINCH-LINTHOUSE TUNNEL.—The announcement by the Minister of Transport, Mr. A. T. Lennox-Boyd, in the House of Commons on December 8, that the Government were prepared to approve, during the next financial year, expenditure on the Whiteinch-Linthouse tunnel under the Clyde at Glasgow, estimated to cost 3,000,000*l.*, and the Glasgow-Stirling road improvement, the first part of which will cost 1,000,000*l.*, has been received with satisfaction in Glasgow. The project is for the construction of twin tunnels, each of 29 ft. internal diameter and each carrying two traffic lanes. Each tunnel will be about 800 yards long.

CLEVELAND AND THE NORTHERN COUNTIES.

RADIO TELEPHONES FOR BILLINGHAM LOCOMOTIVE CREWS.—Imperial Chemical Industries, Ltd., are installing radio telephones in locomotives at their works at Billingham-on-Tees. The central office will be able to maintain communication with engine crews, and charge hands are being issued with portable sets so that they, too, will be able to keep in touch. There are 80 miles of railway at the Billingham Works and wagon movements average about 11,500 weekly.

SHIPBUILDING ON THE RIVER WEAR.—Three vessels scheduled for launching on the River Wear in December will bring the river's output for 1953 to 26 vessels, totalling about 180,000 tons gross. This is the same number of ships as last year, but the tonnage is about 10,000 tons higher. Only four of the vessels launched have been for foreign owners, compared with eight last year. Seven of the 26 ships are tankers, compared with 12 last year.

NEW ROOF AT CARLISLE STATION.—Carlisle Citadel station is to have a new roof and the lighting installation is to be renewed. The work is expected to begin next summer and cost over 200,000*l.* The present roof was constructed in 1878.

THE LATE MR. D. HUTTON.—Mr. David Hutton, of Whitley Bay, who retired seven years ago from the post of engine works manager to the Wallsend Slipway and Engineering Co., Ltd., died on December 9, at the age of 80. He served his time with Messrs. Hall, Russell & Co., Ltd., Aberdeen, and joined the Wallsend company in 1901. In 1937 he became engine works manager and retired in 1946.

LANCASHIRE AND SOUTH YORKSHIRE.

POST-GRADUATE COURSES IN SCIENCE.—Four series of post-graduate lectures on "Modern Colloid Science," "Deformation and Fracture of Metals," "Semi-Conductors and their Applications," and "An Introduction to Electronics," will be held at the University of Liverpool during the spring term of 1954. The courses are intended for persons with graduate or other specialist qualifications, and particularly for industrial scientists and technologists, research workers, engineers, teachers, and others who wish to keep abreast of recent developments in these various fields. Intending students may obtain further particulars from the Director of Extra-Mural Studies, 9, Abercromby-square, Liverpool, 7. A detailed syllabus and book-list for the course will be supplied on enrolment, or may be had on application to the Director.

APPEAL BY SHEFFIELD UNIVERSITY.—At the annual meeting of the Court of Sheffield University, an appeal was made to the city's industries to contribute 30,000*l.* annually towards the upkeep of the Departments of Metallurgy and Engineering. This would free funds for special developments in all sections of the University, said Lieut.-Col. W. H. Olivier, the University treasurer. In the past year, he explained, the University had contributed more than 30,000*l.* from its own funds towards the upkeep of the Engineering and Metallurgy departments. New chairs of science which would directly benefit technological studies, developments in technology and the creation of new medical-school departments were envisaged.

LONG-SERVICE DISTINCTIONS.—At the works of Samuel Fox & Co., Ltd., Stocksbridge, long-service plaques and awards have just been made to 169 men and three women. Since the company started this form of recognition, in 1946, the number of recipients has been 455, which is believed to constitute a record in any one firm. This year the qualifying period was reduced from 45 to 40 years, and, besides the plaque, there was a gift of the recipient's own choice to the value of 35*l.* This year's distribution has involved a sum of 6,020*l.*

THE LATE MR. ADOLF VINER.—Mr. Adolf Viner, who recently retired from the offices of chairman and joint-managing director of Viners Ltd., Sheffield, cutlery manufacturers, died in Sheffield on December 11, at the age of 70. He and his brothers founded the business more than 40 years ago.

COMMEMORATION OF SAMUEL CROMPTON.—The bicentenary of the birth of Samuel Crompton, inventor of the spinning mule, was marked at Bolton on December 3, when the Mayor (Alderman J. Parkes) laid a wreath at the base of the statue of Crompton, in Nelson-square, and another on his grave in the parish churchyard. A chaplet was also placed on the memorial on behalf of the Newcomen Society for the Study of the History of Engineering and Technology. In the evening, lectures were delivered in the Albert Hall by Mr. Harold Hamer, F.L.A., on "Samuel Crompton: his Life and Times," and by Mr. W. A. Hunter, of Textile Machinery Makers (Research), Ltd., on "The Effect of Crompton's Invention on the Lancashire Textile Industry."

THE MIDLANDS.

THE UNIVERSITY OF NOTTINGHAM.—The Court of the University of Nottingham were informed on December 16 that the Council of the University had, that day, gratefully accepted from Mr. C. T. Cripps, M.B.E., chairman and managing director of Pianoforte Supplies Ltd., Simplex Works, Roade, Northampton, a gift of 100,000*l.* for the endowment of two professorial chairs, a Cripps Chair of Metallurgy, and a Cripps Chair of Production Engineering. It is intended that an appointment to the Cripps Chair of Metallurgy should be made for the session beginning in October, 1954, when a degree course in metallurgy will be instituted, as already planned. The Senate had previously approved in principle a proposed degree course in production engineering, but the date when the Chair will be established will now be a matter for consideration.

SCUNTHORPE MARSHALLING YARDS.—The marshalling yards at Scunthorpe, Lincolnshire, handle traffic to and from the iron and steel firms and ancillary industries in the area, and recent statistics show that about 4,000 inwards and 4,000 outwards wagons pass through the yards each week-day and about 2,000 in each direction on Sundays. Traffic continues to increase in step with the development of the iron and steel industry and some congestion is being experienced in the yards. There is no room for expansion, as the yards are hemmed in by the Frodingham iron and steel works, but considerable improvements can be effected by altering and simplifying the layout. A scheme for remodelling the yards, to cost about 110,000*l.*, has been approved by the British Transport Commission.

VAUXHALL'S 100,000TH MOTOR CAR THIS YEAR.—The 100,000th vehicle built by Vauxhall Motors Ltd. this year—a green Velox car—came off the assembly line at Luton at 10 a.m. on December 2. The 11 months in which 100,000 vehicles have been built compares with 31 years (1903-1934) needed for production of the first 100,000. Of the total, 55,662 were Vauxhall motor cars and 44,338 were Bedford lorries, vans, and omnibus and coach chassis; 60,765 of the 100,000 vehicles have been sent or are on their way overseas.

RADIO CONTROL OF PUBLIC SERVICE VEHICLES.—Wolverhampton Corporation Transport Committee have recommended to the Town Council the installation of two-way short-wave radio control for their public-service vehicles. They suggest that a number of radio-equipped cars should be provided, and that they should patrol the area served by the 'buses. Unusual traffic demands could then be reported to a central control station, and a suitable number of vehicles could be sent out to deal with the traffic.

CHEAPER GAS IN THE EAST MIDLANDS.—Mr. Sidney Smith, chairman of the East Midlands Gas Board, announced at a meeting of the Area Gas Consultative Committee in Nottingham on December 11 that reductions were to be made in the price of gas in the Board's area. Both domestic and industrial consumers will benefit, and for firms using gas for continuous process work, the reduction will be 10 per cent.

RECLAMATION OF DERELICT LAND.—Dudley Corporation have submitted to the Ministry of Housing and Local Government plans for the biggest reclamation scheme yet attempted in the borough. It is proposed to develop 300 acres in the Russell's Hall area of the town. The land has been worked many times for coal and ironstone over the last 150 years, and is honeycombed with abandoned mine workings. Part of the land is so heavily undermined that it is considered impossible to build on it, and about 100 acres have been set aside as an open space. The remainder of the area is to be levelled and used for housing.

SOUTH-WEST ENGLAND AND SOUTH WALES.

SOUTH WALES STEEL INDUSTRY.—The output of steel ingots and castings in Wales during November reached a weekly average of 84,130 tons, representing an annual production of 4,374,700 tons. This compared with the previous highest output of 82,450 tons reached last January. The production of pig iron was at a weekly average of 36,636 tons, compared with the previous highest of 34,450 tons attained last May. Richard Thomas and Baldwins Ltd., the steel sheet and tin-plate manufacturers, are to spend 110,000*l.* on the development of welfare amenities at their Ebbw Vale works.

WELSH COAL TRADE.—The output of coal from the South Wales collieries, in the week ended December 5 last, at 521,948 tons, was the highest reached in any week since that ended December 15, 1951. This figure is expected to be exceeded in the subsequent weeks. The voluntary shift worked on Saturday, December 5, also broke previous records, when men at 134 of the 159 pits in the coalfield were at work and produced 43,007 tons of saleable coal.

SOUTH WALES PORTS TRAFFIC.—The trade of the South Wales ports in the first eleven months of this year totalled 20,043,864 tons, compared with 20,836,848 tons in the corresponding period of last year. Imports this year were heavier, rising from 9,211,664 to 9,266,241 tons, but exports declined from 11,625,184 to 10,777,623 tons. Coal and coke shipments continued to make steady progress and, at 3,609,295 tons, were 146,640 tons heavier than a year ago, but patent-fuel shipments slumped from 379,883 tons to 116,059 tons. Iron ore imports rose by 364,000 tons to 2,400,783 tons.

CLOSURE OF A RHYMNEY VALLEY COLLIERY.—Pidwelt Colliery, has been closed, being no longer economical to work. It was the last colliery in the town of Rhymney. The employees will be reabsorbed in other pits in the Rhymney Valleys. The pit was opened in 1920.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Monday morning in the week preceding the date of the meeting.

INSTITUTION OF PRODUCTION ENGINEERS.—*Shrewsbury Section:* Wednesday, December 30, 7.30 p.m., Technical College, Shrewsbury. Films. *Coventry Graduate Section:* Tuesday, January 5, 7.30 p.m., Hare and Squirrel Hotel, Cow-lane, Coventry. Films. *Nottingham Section:* Wednesday, January 6, 7 p.m., Victoria Station Hotel, Nottingham. "The Production Engineer and His Relationships," by Mr. J. H. Bingham. *Wolverhampton Section:* Wednesday, January 6, 7.15 p.m., Wolverhampton and Staffordshire Technical College, Wolverhampton. "Application of Hydraulic Power as an Aid to Productivity," by Mr. F. B. Levetus. *South Wales and Monmouthshire Section:* Thursday, January 7, 6.45 p.m., South Wales Institute of Engineers, Park-place, Cardiff. "Increased Productivity by the Use of Compressed Air," by Mr. C. M. P. Willcox. *Eastern Counties Section:* Friday, January 8, 7.30 p.m., Diocesan Hall, Tower-street, Ipswich. "The Production of Woven Artificial Silk Fabrics," by Mr. E. H. Boas and Mr. N. Ray. *Western Graduate Section:* Monday, January 11, 7.30 p.m., Grand Hotel, Broad-street, Bristol, 1. "Management and the Law," by Mr. H. Jost.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, January 1, 7 p.m., Townsend House, Greycoat-place, S.W.1. Films, introduced by Mr. S. G. Clark. *Midland Section:* Wednesday, January 6, 7 p.m., James Watt Memorial Institute, Birmingham. Chairman's Address on "Brewing and Distilling," by Mr. T. F. Luck. *Institution:* Friday, January 8, 7 p.m., Townsend House, Greycoat-place, S.W.1. "A Modern Vehicle-Actuated Detector and Its Development," by Mr. H. J. N. Riddle. *Sheffield Section:* Monday, January 11, 7.30 p.m., Livesey Clegg House, Union-street, Sheffield. "Clean City Air: An Engineer's Problem," by Mr. James Law.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South Midland Centre:* Monday, January 4, 6 p.m., James Watt Memorial Institute, Birmingham. Discussion on "Technical Education of Other Than National Certificate Students," opened by Mr. J. Ashmore and Mr. D. I. Meyrick. *Mersey and North Wales Centre:* Monday, January 4, 6.30 p.m., Royal Institution, Colquitt-street, Liverpool. "Electronic Telephone Exchanges," by Mr. T. H. Flowers. *District Meeting:* Monday, January 4, 6.30 p.m., Crown and Anchor Hotel, Ipswich. "Modern Developments in Atomic Energy," by Dr. T. E. Allibone. *Measurements Section:* Tuesday, January 5, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. (i) "A Scaling Unit Employing Multi-Electrode Cold-Cathode Tubes," by Mr. K. Kandiah; (ii) "A Sensitive Pulse Triger Circuit with a Stable Threshold," by Mr. K. Kandiah; and (iii) "The Development of a Neutron Spectrometer for the Intermediate Energies," by Mr. F. S. Goulding and others. *North-Western Centre:* Tuesday, January 5, 6.15 p.m., Engineers' Club, Albert-square, Manchester. "The Co-ordination of Insulation of High-Voltage Electrical Installations," by Mr. J. S. Cliff. *North Midland Centre:* Tuesday, January 5, 6.30 p.m., Offices of the Yorkshire Electricity Division, 1, Whitehall-road, Leeds. "Voltage Transformers and Current Transformers Associated with Switchgear," by Mr. W. Gray and Mr. A. Wright. *Southern Centre:* Wednesday, January 6, 6.30 p.m., Offices of the South Eastern Electricity Board, Hove. "The Operation of Power Transformers," by Mr. E. T. Norris. *Institution:* Thursday, January 7, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Parsons Memorial Lecture on "Continuity of Electricity Supply," by Mr. H. Leyburn.

INSTITUTION OF MECHANICAL ENGINEERS.—*North-Eastern Branch:* Monday, January 4, 6 p.m., Neville Hall, Westgate-road, Newcastle-upon-Tyne. Annual General Meeting. *London Graduates' Section:* Tuesday, January 5, 6.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Modern Thermal Power Stations," by Mr. R. C. Nicoll and Mr. J. Griffin. *Institution (Internal Combustion Engine Group):* Friday, January 8, 5.30 p.m., Storey's gate, St. James's Park, S.W.1. (i) "An Experimental Investigation into the Effect of Fuel Addition to the Intake Air on Performance of a Compression-Ignition Engine," by Mr. W. T. Lyn; and (ii) "The Effect of Auxiliary Fuels on the Smoke-Limited Power Output of Diesel Engines," by Mr. L. D. Derry, Dr. E. M. Dodds, Dr. E. B. Evans and Mr. D. Royle. *Institution:* Friday, January 15, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Thomas Lowe Gray Lecture on "High-Temperature Steam and Gas-Turbine Machinery for Marine Propulsion," by Dr. T. W. F. Brown. AUTOMOBILE DIVISION.—*London:* Tuesday, January 12, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Two-Stroke Automotive Compression-Ignition Engines," by Professor Hans List.

INSTITUTION OF THE RUBBER INDUSTRY.—*North-Eastern Section:* Monday, January 4, 7 p.m., Neville Hall, Westgate-road, Newcastle-upon-Tyne. "Rubber and Ships," by Dr. W. J. S. Naunton. *Midland Section:* Monday, January 11, 6.45 p.m., James Watt Memorial Institute, Birmingham. "What the Aircraft Manufacturer Wants from the Rubber Industry," by Mr. J. H. Cork. *Preston Section:* Monday, January 11, 7.15 p.m., Bull and Royal Hotel, Church-street, Preston. "The Role of Latex in the Rubber Industry," by Mr. E. W. Madge. *Leicester Section:* Wednesday, January 13, 7.30 p.m., Bell Hotel, Leicester. "Extruders and Extrusion," by Mr. H. C. Harrison.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Sheffield Branch:* Monday, January 4, 7.30 p.m., Sheffield College of Commerce and Technology, Pond-street, Sheffield. "Examples of Loam Moulding as Applied to Production of Pump Castings and Impellors," by Mr. E. Clipson. *Lincolnshire Branch:* Thursday, January 7, 7.15 p.m., Lincoln Technical College, Lincoln. "Aluminium Pattern Equipment by the Pressure Cast Plaster Process," by Mr. D. H. Potts. *Scottish Branch:* Saturday, January 9, 3 p.m., Royal Technical College, Glasgow. "Core Assembly as a Production Aid to the Jobbing Foundry," by Mr. E. H. Beech and Mr. J. Hoyes. *Newcastle Branch:* Saturday, January 9, 6 p.m., Neville Hall, Westgate-road, Newcastle-upon-Tyne. "Residual Stresses in Castings," by Dr. R. N. Parkins. *West Riding of Yorkshire Branch:* Saturday, January 9, 6.30 p.m., Technical College, Bradford. "Aluminium Casting Alloys," by Mr. R. Mercer.

INSTITUTION OF CIVIL ENGINEERS.—*Works Engineering Division:* Tuesday, January 5, 5.30 p.m., Great George-street, S.W.1. "Swedish Underground Hydro-Electric Power Stations," by Mr. J. F. Hagrup.

REINFORCED CONCRETE ASSOCIATION.—Tuesday, January 5, 6.45 p.m., College of Technology, Sackville-street, Manchester. "Concreting Methods and Machinery," by Mr. A. P. Lambert. Wednesday, January 6, 6.30 p.m., Liverpool Engineering Society, 9, The Temple, 24, Dale-street, Liverpool. "Concreting Methods and Machinery," by Mr. A. P. Lambert.

INSTITUTE OF METALS.—*Oxford Local Section:* Tuesday, January 5, 7 p.m., Cadena Café, Cornmarket-street, Oxford. "Industrial Methods of Electroplating," by Dr. G. E. Gardam. *Institute:* Wednesday, January 6, 10.30 a.m., Birmingham University, Edgbaston, Birmingham. Discussion on "Lubricants for Metal-Working Operations in the Non-Ferrous Metals Industries." *London Local Section:* Thursday, January 7, 6.30 p.m., 4, Grosvenor-gardens, Westminster, S.W.1. "The Roger-stone Strip Mill," by Mr. F. King.

INCORPORATED PLANT ENGINEERS.—*London Branch:* Tuesday, January 5, 7 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. "Transmission Equipment and Bearings," by Mr. F. J. Walters. *Edinburgh Branch:* Tuesday, January 5, 7 p.m., 25, Charlotte-square, Edinburgh. "Power Factor Correction," by Mr. Hugh Ferguson. *Southampton Branch:* Wednesday, January 6, 7.30 p.m., Polygon Hotel, Southampton. "History of Southampton's Water Supply," by Mr. Joseph Hawksley. *Peterborough Branch:* Thursday, January 7, 7.30 p.m., Offices of the Eastern Gas Board, Church-street, Peterborough. "Industrial Uses of Magnetic Power," by Mr. G. T. Hawker.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*London Section:* Wednesday, January 6, 6.30 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. "Engineering Design of Very-High-Frequency Multi-Channel Telephone Equipment," by Mr. W. T. Brown. *Scottish Section:* Thursday, January 7, 7 p.m., The University, Edinburgh. "Radio Astronomy," by Mr. H. Seddon. *North-Western Section:* Thursday, January 7, 7 p.m., College of Technology, Sackville-street, Manchester. "The Manchester University Computor," by Mr. D. B. G. Edwards.

TELEVISION SOCIETY.—Wednesday, January 6, 6.45 p.m., Film House, Wardour-street, W.1. "Marconi Television O.B. Unit," by Mr. C. Carrington.

INSTITUTION OF SANITARY ENGINEERS.—Thursday, January 7, 6 p.m., Caxton Hall, Westminster, S.W.1. Presidential Address by Mr. E. H. Vick.

INSTITUTE OF FUEL.—*South Wales Section:* Friday, January 8, 6 p.m., Technical College, Bridgend. "Extension at Llandarcy," by Mr. F. V. M. Bell. *North-Eastern Section:* Monday, January 11, 6.30 p.m., King's College, Newcastle-upon-Tyne. "The Calorific Value of Coal," by Mr. J. Brown.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Western Counties Branch:* Friday, January 8, 6 p.m., The University, University-road, Bristol. "Hangers at London Airport: Design of Long-Span Prestressed-Concrete Beams," by Mr. A. J. Harris.

MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, January 8, 6.45 p.m., Engineers' Club, Manchester. Discussion on "Training Designer-Draughtsmen."

INSTITUTE OF PACKAGING.—*Northern Area:* Monday, January 11, 6.30 p.m., Old Nag's Hotel, Manchester. Discussion on "Laminates."

PERSONAL.

At the election of Officers and Council of the Royal Society, held on December 10, DR. E. D. ADRIAN, O.M., was made President; SIR THOMAS MERTON, treasurer and vice-president; SIR EDWARD SALISBURY, C.B.E., and SIR DAVID BRUNT, secretaries and vice-presidents; and SIR CYRIL HINSHELWOOD, foreign secretary.

MR. C. H. KAIN, A.M.I.Mech.E., F.I.M., has been elected chairman of the Council of the British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10, in succession to MR. F. H. LLOYD, B.A.

MR. GEORGE WOOD, C.B.E., who has been chairman of Thos. W. Ward Ltd., Albion Works, Sheffield, since 1950, will retire on January 1, 1954, but will remain a director and has been appointed vice-president. His successor is MR. H. W. SECKER, at present joint managing director. MR. ARNOLD CARR has been appointed assistant managing director and MR. RAWSON F. STAGG, a local director since 1947, now becomes a full director.

MR. A. W. V. AGUTTER has been elected President of the British Association of Machine Tool Merchants, St. Stephen's House, Victoria Embankment, London, S.W.1, in succession to MR. G. A. PARKER.

MR. H. A. HEPBURN, C.B.E., B.Sc. Eng. (Lond.), M.I.Mech.E., "Curlew Hope," Mayfield-road, Weybridge, Surrey, formerly H.M. deputy chief inspector of factories, states that he is now available for consultation on safety and health requirements for all classes and descriptions of machinery, plant and process work.

MR. B. C. PYLE, A.M.I.E.E., senior assistant engineer (generation construction department), Southern Division, British Electricity Authority, has been appointed generation engineer (construction) in the same division. He succeeds Mr. C. W. A. Priest, B.Sc. (Eng.), A.M.I.Mech.E., M.I.E.E., who as stated on page 175, *ante*, is now chief generation engineer (construction), South Wales Division.

MR. L. D. WATSON has been appointed deputy managing director, and MR. J. W. SCRUBY, financial director of the Weyburn Engineering Co. Ltd.

MR. A. J. DAVIES has been made district engineer, erection department, Cardiff, Metropolitan-Vickers Electrical Co. Ltd., following the retirement of MR. T. L. HUTCHINSON.

MR. GEORGE W. P. PAGE, A.C.G.I., A.M.I.E.E., is retiring at the end of the year from the publicity department of the British Thomson-Houston Co., Ltd., Rugby, after 30 years of service with the company.

MR. Z. STOKOWIEC, A.M.I.Mech.E., F.I.M., has been appointed manager of the new bronze foundry of Sheepbridge Engineering Ltd., Chesterfield.

MR. J. A. CLARK and MR. M. W. CLARK have been appointed directors of the Plessey Co. Ltd., Ilford, Essex. MR. J. A. SMITH, formerly a director, has retired from that office owing to ill health. MR. W. F. CROSS has been appointed joint secretary with MR. E. H. OUSTON.

MR. R. ELLIS, previously a member of the engineering staff of Leyland Motors Ltd., Leyland, Lancashire, has been appointed technical sales representative.

MR. D. R. MACKIE, a director and general manager of sales, Monsanto Chemicals Ltd., is to be commercial director of the company as from January 1, 1954. The position of general manager of sales is to be discontinued and the responsibility transferred to three sales controllers, namely, MR. E. L. PIXTON, MR. D. C. M. SALT, and MR. J. S. HUNTER. MR. W. M. THOMPSON is to be director of purchases.

INTERNATIONAL COMBUSTION LTD., and CARL STILL, the European designers of coke-oven plant, have been combined in a new organisation, INTERNATIONAL-CARL STILL, of 19, Woburn-place, London, W.C.1.

MR. J. E. T. WATSON, sales manager to the Chaseside Engineering Co. Ltd., since 1948, has now joined F. E. Weatherill Ltd., Union-row, London, N.17, in a similar capacity. The firm also announce that they have been appointed the main distributors for Great Britain and overseas territories for the "Epping Auto-Shunter," made by EPPING ENGINEERS LTD.

MAIDEN & CO. LTD., Hyde, Cheshire, have appointed REYNOLDS & WILSON, 58, Victoria-street, London, S.W.1, to be their representatives in London and the southern counties.

A new company, Q.V.F. Ltd., Mill-street, Stone, Staffordshire, has been formed to market Visible Flow glass pipeline manufactured by James A. Jobling & Co., and Quickfit industrial plant in glass by Quickfit and Quartz Ltd. The title of the new company is an abbreviation for Quickfit Visible Flow. The chairman is SIR GRAHAM CUNNINGHAM, chairman and managing director of the Triplex group of companies. The managing director is MR. BRIAN H. TURPIN. MR. J. G. WINDOW, formerly industrial sales manager of the Jobling company, is also on the board, and the technical director is MR. J. MCNICOL BRUCE.

CIRCULAR-KILN BRICK-MAKING PLANT.

(*For Description, see Page* 825.)

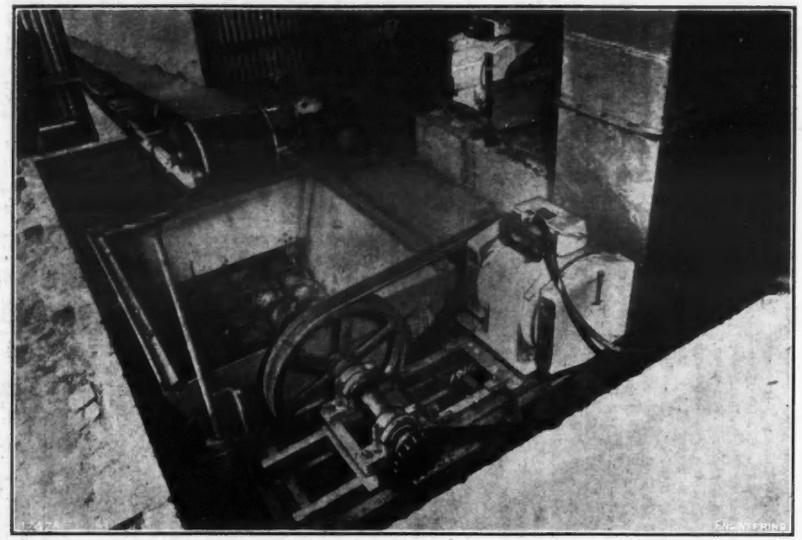


FIG. 1. EVEN FEEDER AT END OF CLAY CONVEYOR.

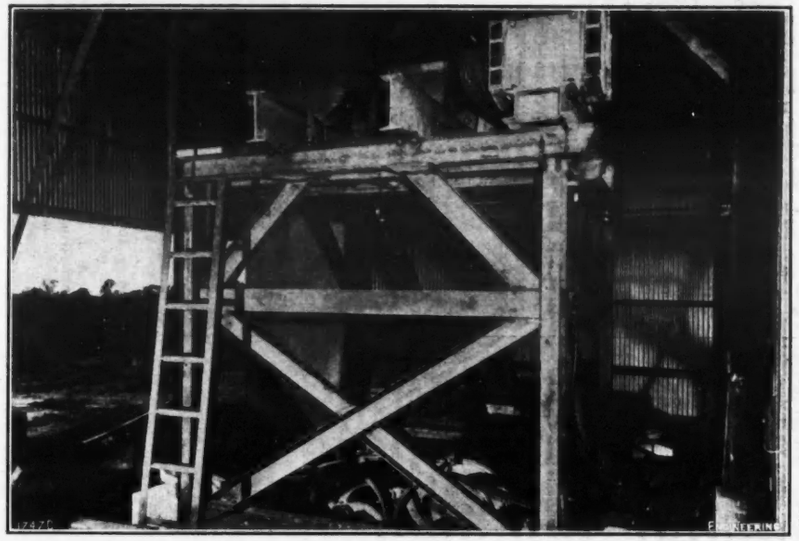


FIG. 2. BAR DISINTEGRATOR AND SMOOTH-ROLL CRUSHER DRIVES.

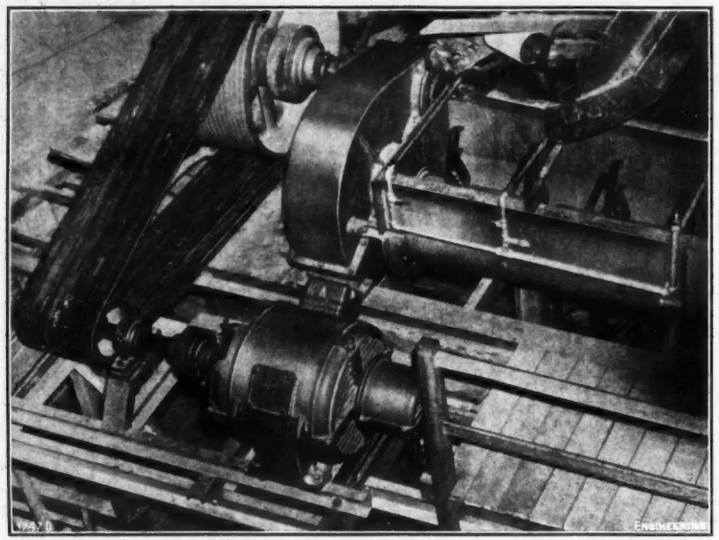


FIG. 3. PUG MIXER.

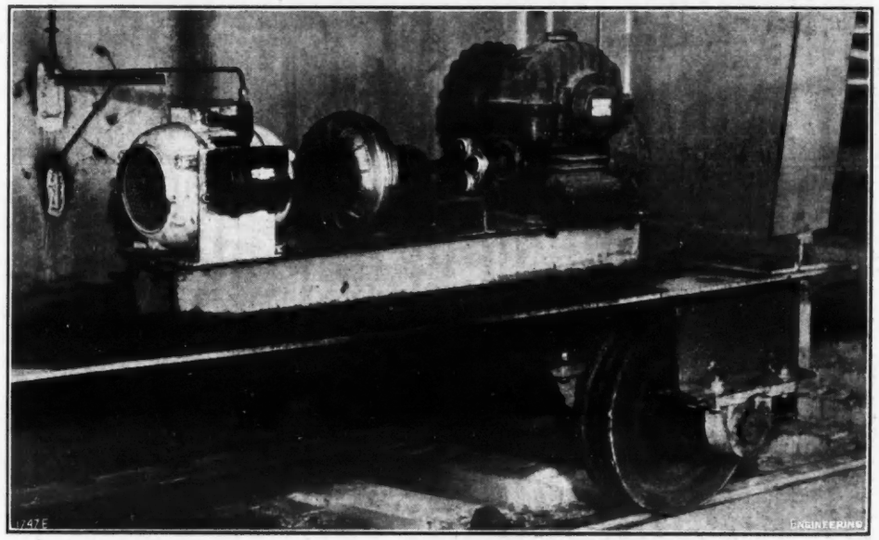


FIG. 4. 3-H.P. DRIVE FOR MOBILE GEARED HOOD.

ENGINEERING.

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

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For Canada	£5 5 0

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ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than **first** post **Monday**.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

INDEX TO VOL. 175.

The Index to Vol. 175 of ENGINEERING (January-June, 1953) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, copies of the Index are being distributed only in response to such applications.

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ENGINEERING

FRIDAY, DECEMBER 25, 1953.

VOL. 176. No. 4587.

A NEW SYSTEM.

THE manager of an engineering works, however efficient he may be in delegating responsibility, is often reluctant to admit the necessity of a major change in organisation. If the change will bring benefits only over a long period, the inevitable dislocation of the existing, smoothly working organisation may seem to be a powerful argument for not changing. An issue of this kind, involving the design and production departments, is likely to be considered by many engineering managements in the next few years, and those which elect to make no change will probably find that they are working more and more at a disadvantage.

The new British Standard system of limits and fits has been published recently. In general, it corresponds to the International Standards Association system, which has been accepted by most of the Western world, as well as by Russia. The principles and practical application of the British system were expounded in two papers presented to the Institution of Mechanical Engineers on December 18. Mr. H. G. Conway, describing the technical features of the system, and Mr. G. J. Pearmain dealing with the practical application, left no doubt that the system admirably satisfies both the logical approach of the drawing office and the practical compromise of the shops. Paradoxically, it presents such a wide range of limits and fits that its claim to be a "standard" might almost be disputed. The explanation is that the system has been worked out with infinite care to cater for all, or nearly all, requirements of industry, and each standards-specifying organisation—whether a single engineering firm or a group of firms—must make its own selection to suit its products, methods of production, etc. Much credit is due to the engineers who have worked out the comprehensive details of the system; it is a formidable piece of work which, now that it is published, will enable engineers to prepare ranges of standard limits and fits for their works. It will not be a matter of indiscriminate selection; that would only defeat the object of the Standard. Mr. Pearmain, describing the procedure for making a selection, pointed out that as soon as engineers in this country become familiar with the system they will be able to speak of, for example, a "p" shaft fit, knowing that engineers from other countries will know precisely what is intended.

In planning a selection from B.S. 1916, the first step—assuming that the hole basis with unilateral tolerances is adopted—is to decide what classes of fit are required. When this has been done a selection is made from B.S. 1916 to give the required fits in conjunction with a chosen series of tolerances. Alternatively, some firms will probably prefer to use the standard fits which are nearest to those already in use. To help engineers who decide to adopt this plan, B.S. 1916 gives a table of equivalents in the B.S. 164 (the former British Standard) and Newall systems. Nevertheless, an adequate selection to suit a particular works requires very careful consideration. "It is not sufficient," Mr. Pearmain said, "to give each draughtsman a chart of tolerances and fits, with permission to use them at his discretion, for their application is a skilled task and should be regarded as such." One way of overcoming the difficulty, he suggested, was to place the responsibility for the selection of all tolerances and fits in the hands of a senior engineer, or even, if the circumstances warranted it, to form a small section with these duties. They would be able to assess rapidly the relative importance of the various conditions encountered in each application, and their accumulated experience would result in considerable savings by freedom from stoppages in production and changes in tolerances which might otherwise occur. Such a section, he thought, might also include in its activities the overall checking of designs for conformity to standards, that is, to ensure that the fullest use is made of those standards for raw materials, finishes, preferred sizes, etc., that the organisation recognises.

To help the designer to appreciate more fully the physical significance of, say, a clearance of 0·001 in., Mr. Pearmain recommended that each drawing office should be provided with a set of metal standards, i.e., gauges, representing the various hole and clearance shaft limits used in the organisation. These standards could be made to a convenient size—say, 1 in. in diameter—and would form a valuable reference "library" to indicate the feel of the various fits. They would be particularly useful for designers who, through lack of practical experience in the shops, often failed to realise the significance of the tolerances and allowances they specified, either in terms of the resulting fit, or of machining problems.

The full benefit of B.S. 1916 can only be reaped if the system is applied in conjunction with an agreed series of preferred sizes for the dimensions of fitting parts. As Mr. Pearmain remarked, a well-developed series helps to restrict the variety of sizes specified by designers, while in no way restricting their design function, and will lead to economies in material, tool and gauge stocks, storage space and stock records. The scope for long-term savings in the engineering industry, made possible by B.S. 1916 and the two papers which give the reader a deeper understanding, cannot be computed, but it is undoubtedly considerable. The onus is now on engineering firms to accept the challenge of a change and carry on the good work so ably started by the British Standards Institution committee.

ATOMIC POWER AND OHIO.

IT is a well-known, and a not altogether unpraiseworthy, characteristic of the human being to regard the race of which he is a member and the institutions with which he is voluntarily or compulsorily connected as superior to any other. Englishmen and Scotsmen have no doubt of the relative preeminence of their two countries (even though the latter may be the more vocal on the subject), while the rivalry that exists between those who have been educated at Oxford and Cambridge and between, say, the denizens of Manchester and Salford is well known. That the same attitude exists on the other side of the Atlantic is equally clear, and has been effectively brought out in a humorously cynical spirit by such writers as O. Henry and Sinclair Lewis. While, however, it is a quality which enlists some sympathy it may also give rise to situations demanding tact to handle.

It may therefore be deduced that when Mr. Philip Sporn, the well-known president of the American Gas and Electric Company, of New York, was asked to address the 60th annual meeting of the Ohio Chamber of Commerce at Columbus a short time ago, he accepted with some qualms. Ohio, it may be recalled, with an area of 40,760 square miles is the third largest State in the Union and its inhabitants number over eight million. It has been the birthplace of more Presidents of that great nation than any other State, a circumstance which lends piquancy to the recent doubt whether, owing to some ancient legalistic oversight, it is really part of the Union at all. Above all, it is rich in deposits of high quality coal and iron ore, holds a leading place in the consumption of electricity and during the past few years has been the site of many interesting investigations into the mysteries of atomic power. Mr. Sporn was therefore wise to link State patriotism with the developments that are taking place in the closely related fields of electricity supply and atomic power and thus to show, doubtless to the satisfaction of his audience, that Ohio is likely to play an important part in both these directions in the future.

The picture he painted was, in fact, not unimpressive. Ohio is in the heart of the Eastern Coal Province, which at present produces about 85 per cent. of all the coal mined in the United States. There is every indication, too, that it still possesses ample reserves of this fuel, although geological experts not unexpectedly differ as to the period over which these reserves will be adequate. In addition to being the home of many a President, Ohio was also the birthplace of Edison; and by what can only be described as a happy coincidence was in 1952 responsible for an annual electrical consumption of 2,900 kWh per inhabitant, compared with 2,600 kWh for Pennsylvania, 2,100 kWh for New York and 2,200 kWh for the country as a whole. Of this output nearly 99 per cent. was generated from coal. The maintenance of this leading place is likely to be assisted rather than hindered by the work that is being, or is intended to be, carried out in the State by the Atomic Energy Commission, especially in extending developments in this field away from military defence (which, of course, up till now has been the main pre-occupation) into more peaceful channels.

For instance, the erection in Pike County of what is known as the Portsmouth Area Project, has necessitated the construction of a 1,000-MW steam station at Kyger Creek to supply part of the power required. The presence of the Mound Laboratory at Miamisburg in Montgomery County, where highly-classified development work connected with radio-active processes is being conducted; the Fuel Materials Production Centre at Fernald, west of Cincinnati, where the raw materials needed in the production of more concentrated fissionable material are processed; and the Evendale factory of the General Electric Company at Lockland, where work on the development of a reactor for aircraft propulsion by nuclear power is being carried out, all require electric power for their day-by-day activities, and all contribute to the important part that form of energy is playing within the State boundaries. This is shown by the fact that the 15 power companies serving the Ohio Valley area have contracted to meet a load of 1,800 MW with an annual consumption of 15,000 million kWh at Portsmouth. Such an event is worth recording, since the latter figure is equal to about two-thirds of the total electricity consumption in Ohio in 1952. It is also interesting from the fact that the plant will be connected to the Kyger Creek power station by overhead lines operating at 330 kV. A companion plant under construction at Clifty Creek in Jefferson County, Indiana, though not within the boundaries of Ohio will also feed into this system.

Mr. Sporn was, however, careful to point out that the relationship between electricity supply and atomic power may not for long be only one-way. It is obvious that the principal peace-time use of atomic power will be to generate electricity. It is therefore natural that he should have drawn the attention of his audience to the future, when atomic energy will have been so far developed that it can take its place beside, and perhaps be even more economical than, the forms with which we are now familiar. At the same time, perhaps to lull any anxiety that the development of new methods would rapidly result in the replacement of coal, he added that atomic power is not just round the corner, but that much hard, expensive and time-consuming work would be necessary before it can become a reality. It must, in particular, justify itself by being competitive with existing power sources. Actually, this position has not yet been reached and Mr. Sporn was on firm ground in holding that, in spite of the work that has been done, not only in the United States, but in this country and in Norway, power-reactor technology has not yet reached a state when it would be possible to use it to produce electric power at a cost comparable with that generated by other means. Those means, he added slyly, signified in Ohio the burning of coal. In fact, owing to the State's situation with respect to coal it is not likely to benefit from atomic power as soon as other areas, both in America and elsewhere, which are not so ideally situated with respect to conventional sources of energy.

This conservative view is, of course, the same as that held by engineers in this country. Experiments comparable to those in the United States are being made on a 45-MW plant in Cumberland. As, however, Sir John Hacking pointed out in his presidential address to the Junior Institution of Engineers, of which we give an account on page 827, of this issue, until more experience is gained with construction and operation, it is impossible to make reliable economic comparisons with coal-fired plant. At the same time, difficulties in technical development do not appear to be insuperable; and it is not unlikely, in his view, that the next three or four years will see a considerable extension of this type of installation. In fact, there seems no reason to doubt that in this country atomic power might contribute some 2,000 to 3,000 MW in 20 years time.

If at this season of the year, when the black cloud of industrial dispute has lifted temporarily, it is permissible to comment on the position with some levity, it seems clear from Mr. Sporn's address that Ohio is "sitting pretty." In fact, even if those concerned succeed in reducing the titanic force of the atom to the fruitful service of mankind (to paraphrase the words of President Eisenhower), that State will still be in the forefront of progress and its welfare may well be increased rather than mitigated.

NOTES.

"THE CONQUEST OF THE AIR."

A COLLECTION of photographs of some of the principal landmarks in aviation, leading up to, and following, the first controlled sustained flight by the Wright Brothers on December 17, 1903, has been compiled and issued by the Science Museum in a booklet entitled "The Conquest of the Air," by Mr. P. L. Sumner (H.M.S.O., price 1*s.* net). The photographs are preceded by notes on the development of balloons, airships, and heavier-than-air craft. The first recorded man-carrying flights were in 1783, in a Montgolfier hot-air balloon by M. Pilatre de Rocier, followed very soon after by Professor Charles and M. Robert in a hydrogen balloon, which rose to 300 ft. over Paris. Two years later M. Blanchard crossed the English channel in a balloon. The first successful flight by a dirigible airship was by M. Henri Giffard in 1852; the ship had a capacity of 88,000 cub. ft. and was propelled by a 3-h.p. steam engine. The history of heavier-than-air craft can be said to date from 1804, when Sir George Cayley, the father of aeronautics, flew his first successful model glider; the first powered model aircraft was flown by John Stringfellow in 1848, but many years were to elapse before full-scale powered flights were attempted. During the latter half of the Nineteenth Century there was considerable activity in gliding experiments, the most famous being those of Otto Lilienthal between 1890 and 1896, when he was killed in a crash; it was Lilienthal's work that directed the interest of the Wright Brothers to aviation. After their famous flight in 1903, three years elapsed before the first sustained flight in Europe by Santos Dumont. In 1909, M. Blériot made the first aeroplane crossing of the English Channel, and ten years later Captain Sir John Alcock and Sir Arthur Whitten-Brown successfully crossed the Atlantic in a Vickers-Vimy aircraft, from West to East. In the same year the British R.34 airship crossed the Atlantic in both directions. The year 1919 also saw the introduction of the first regular commercial air service between London and Paris. The first jet-propelled aircraft, a German Heinkel 178 aeroplane with an experimental HE53 jet engine, flew on August 27, 1939; subsequently, it crashed. In 1941, the successful Gloster-Whittle E28/39 jet aircraft flew, and the jet propelled era may be said to date from then. Six years later the "sound barrier" was penetrated by the American Bell X-S1 rocket-propelled aircraft, piloted by Major Charles E. Yeager; in the Science Museum booklet, this flight is wrongly attributed to Mr. W. Bridgeman, the first pilot to reach Mach 2.

NATIONAL RESEARCH DEVELOPMENT CORPORATION.

The National Research Development Corporation is concerned, either alone or jointly with industry, in developing 14 projects which might otherwise have failed for lack of support from other sources. The fourth annual report, up till June 30, 1953, has now been published and copies are obtainable from H.M. Stationery Office, price 9*d.* The function of the Corporation is twofold: to secure, where public interest so requires, the development of inventions made in the course of work done in Government or other public establishments, or of inventions which otherwise are not being sufficiently exploited; secondly, the Corporation is required to acquire, hold and dispose of the rights of the developments undertaken for the benefit of the public. Since being formed, applications have been made in the United Kingdom and Overseas for 2,224 patents, and patents have already been granted in 501 instances within the United Kingdom and for a further 227 applications elsewhere. In addition, the Corporation is now a party to a total of 258 licence agreements, of which 77 were revenue-earning during the year under review, and the net receipts therefrom were a little more than 23,000*l.* The gross expenditure of the Corporation during the year was rather more than 120,000*l.* Further legislation is required before June, 1954, when the Corporation's present borrowing powers expire, if the money necessary for continued activity is

to be forthcoming. The development projects now in hand cover a wide field and include the four following items. The largest single commitment of the Corporation relates to development of electronic digital computers of the type designed by Professor F. C. Williams, F.R.S., at Manchester University; work undertaken with this machine has been described in ENGINEERING, on pages 230 and 349, *ante*. The development of a light steam engine, using wood or other vegetable material as fuel, is being undertaken in conjunction with Ricardo and Company (Engineers), Limited; such an engine, would be of great value in overseas territories, such as India and Pakistan. The construction of a prototype of a photogrammetric-plotting instrument was expected to be completed by the end of 1953. The fourth example concerns a group of inventions relating to a regenerative system of mechanical transmission; the system, known as the "Gyreacta," has particular applications to public-service vehicles. The address of the Corporation is 1, Tilney-street, London, W.1.

THE INSIGNIA AWARD OF THE CITY AND GUILDS OF LONDON INSTITUTE.

Some twelve months ago the Insignia Award in Technology was established by the Council of the City and Guilds of London Institute to provide a high qualification for persons in industry whose initial training was based primarily upon practical experience combined with theoretical study and who, having gained appropriate City and Guilds' certificates as craftsmen or technicians, have now advanced in their industry by a combination of progressive experience and further study. A candidate upon whom "The City and Guilds of London Institute's Insignia Award in Technology" is conferred will receive a Warrant specifying thereon the section of industry and the branch of technology in which his knowledge and skill are recognised, and under the Institute's Royal Charter he will be authorised to use the insignia letters "C.G.I.A." A register of Insignia Awards will be maintained by the Institute. A candidate must be at least 30 years of age and be sponsored by three referees of appropriate standing. He must have been apprenticed or otherwise suitably trained in his industry, must hold relevant Full Technological Certificates of the Institute, and have had a minimum of seven years' progressive experience in his industry. He is then required to write a thesis of some 10,000 to 20,000 words on a technological topic associated with his work, which must show that the candidate is acquainted with the current practice and problems of his industry. If this thesis is reported upon satisfactorily by the Assessor appointed by the Institute, the candidate is required to appear for interview before a panel nominated by the Institute for this purpose. The Insignia Award Committee, on the recommendation of the panel, will then make their final decision as to the award, subject to ratification by the Council of the Institute. Candidates are considered in terms of five broad industrial groups, namely: chemical industries, constructional industries, electrical industries, mechanical industries and textile industries. The award committee includes two representatives from each of these sections of industry, together with co-opted members. The stage has not yet been reached when a first list of recipients of the award can be issued, but candidates' theses are now being received and considered. The Insignia Award Committee is considering a scheme whereby a précis of theses written by successful candidates may be made available to all who are interested and, in exceptional cases, where guidance may be given to ensure full publication. In connection with the inauguration of the scheme, and to set the standard of achievement to which it is hoped future C.G.I.A.'s will aspire, the Council have, in each of the five industrial groups, made up to three Foundation Awards to distinguished representatives of industry, who, in their early days, had gained City and Guilds' certificates. These were formally bestowed on the recipients by the Duke of Edinburgh as the President of the Institute, at its last yearly meeting. A copy of the Regulations governing the award, together with notes for the guidance of candidates, will be sent on application to the Director, Department of Technology (I.A.), City and Guilds of London Institute, 31, Brechin-place, London, S.W.7.

SALES TO NORTH AMERICA.

Britain's appeal to consumers in Canada and the United States lies mainly in her capacity for producing high-quality goods. Quality, in fact, is, and will remain, this country's greatest selling asset so far as markets in North America are concerned. In this connection, however, it is considered that purchase tax, by fostering the manufacture of cheaper articles, is having an adverse effect on the quality of British products. The correct packaging of all articles continues to be of great importance, owing to the increase in the number of self-service shops. These are some of the conclusions reached by a delegation from the Scottish Council (Development and Industry), who have now returned to Britain after an intensive tour of 1,500 miles across the United States and in Eastern Canada, undertaken to create interest in next year's Scottish Industries Exhibition. Although few criticisms of British packaging methods were forthcoming from Canadian or American buyers, it appeared obvious to the delegates that the general standard of packaging in those countries was now higher than on their previous visit four years ago. Altogether, the districts visited by the deputation, including Texas and California, two of the most rapidly developing areas in the United States, are responsible for 30 per cent. of the country's total retail turnover; and more than 80 per cent. of the firms visited undertook to send buyers to the exhibition, which will be held in the Kelvin Hall, Glasgow, in September, 1954. Executives displayed great interest in new projects and, as was to be expected, anything of a novel character was found to have special sales value. Much interest was aroused when it was realised that Scotland was arranging a trade fair of international importance without State assistance, financing it by a private guarantee fund. The mission to North America included Lord Bilsland, the President of the Council, and Mr. R. A. Maclean, chairman of the Council's exhibition committee. Their main object was to stimulate interest in the exhibition and to secure the support of buyers of consumer goods, including users of capital equipment required by engineering and constructional undertakings.

LETTER TO THE EDITOR.

WILLIAM GILBERT.

TO THE EDITOR OF ENGINEERING.

SIR,—During the past 300 years, in innumerable encyclopædias, dictionaries, histories, treatises, catalogues, etc., published in many languages, the name of the author of *De Magnete* has been given as William Gilbert; and just 50 years ago, when you recorded the Gilbert Tercentenary gathering at the Institution of Civil Engineers, when an address was given by the great Gilbertian student Silvanus Thompson, you naturally wrote of "William Gilbert." With these things in mind, it was with surprise that, in your last issue on page 755, *ante*, I read of "The 350th Anniversary of William Gilberd." I am afraid I do not understand the reason for this change in spelling, especially as Gilbert's father's name was apparently spelt Gylberd and not Gilberd. I cannot but think that the action of the good people of Colchester, in changing the spelling to Gilberd, is a little quixotic.

In an article published first in the *Nineteenth Century* for January, 1886, and secondly in his volume *The Meaning of History* (1894) Frederic Harrison dealt with "Palaeographic Purism." The article began "In this age of historical research and archaic realism, there is growing up a custom which, trivial and plausible in its beginnings, may become a nuisance and a scandal to literature. It is the custom of re-writing our old familiar proper names; of renaming places and persons which are household words: heirlooms in the English language." Harrison girded at those who would write Krete for Crete, Kleopatra for Cleopatra, Ælfred for Alfred, Eadgar for Edgar and Cant-wara-byryg for Canterbury! He pointed out that our Conqueror was Willelm and not William, and that there are about 40 ways of spelling Shakespeare. "Palaeography," he concluded, "should keep to its place, in commentaries, glossaries, monographs and the like. In English literature, the literary name of the greatest ruler in the West is Charlemagne, the literary name of the most perfect of beings is Alfred; and the literary name of the greatest of poets is Shakespeare. The entire world, and not England alone, has settled all this for centuries." So, Sir, it seems to me that the world long ago has settled that the literary name of "the father of magnetic philosophy" is William Gilbert.

Yours faithfully,
EDGAR C. SMITH,
Eng. Capt., R.N. (Ret.).

Keepers Corner,
Horley, Surrey.
December 13, 1953.

OBITUARY.

SIR ARTHUR WINDER.

STEEL metallurgists in this country and in many other parts of the world will receive with regret the news of the death of Sir Arthur Winder, which occurred at Park Hospital, Manchester, on December 11. Arthur Benedict Winder, who relinquished his position as a director and general manager of the English Steel Corporation, Limited, and other companies, on September 30, 1944, was the son of the late Rev. John Harrison Winder, B.A., Vicar of Woodhouse, near Sheffield, and was born on February 12, 1875. Owing to the death of his parents when he was still a youth, and following his education at Giggleswick School, he was compelled to earn his own living at a comparatively early age. He started work in the casting pit of the open-hearth furnace department of Thos. Firth and Sons, Limited, in 1894, and in his spare time studied metallurgy under the late Professor J. O. Arnold, F.R.S., at the Sheffield Technical School, now the Applied Science Department of the University of Sheffield. He obtained the Associateship in Metallurgy, with honours, and gained the Mappin Medal and Premium which are awarded annually to the most successful evening student in the final examination for the Associateship in Ferrous Metallurgy.

In 1906, Winder left Thos. Firth and Sons and entered the works of Jonas and Colver, Limited, as manager of that firm's new open-hearth plant. Realising from his own experience the difficulty of maintaining efficiency when working for 12 hours a day under hard physical conditions, he introduced the 8-hour day in his new melting shop some six years before it became general throughout the country. In 1918, Winder returned to Messrs. Firth and Sons as head of the steel-melting department. In 1921 he became works manager, and a director of Industrial Steels, Limited, which firm was purchased by the English Steel Corporation, Limited, in 1932. In that year, at the request of the late Sir Charles Craven, chairman and managing director of the English Steel Corporation, Winder became works director of several of this firm's steel and other works.

Thus, until his retirement in 1944, at the age of 69, he was a director and general manager of the English Steel Corporation, Limited, the Darlington Forge Limited, and Industrial Steels, Limited, and a director of Vickers-Armstrongs Limited, Firth-Vickers Stainless Steels, Limited, the Oughtibridge Firebrick Company, Limited, and High Speed Steel Alloys, Limited. For his services to the industry and to his country he was created a Knight in 1943, and will always be remembered as one of the few men in this country who, working his way up from an open-hearth steel-furnace casting-pit hand to first-hand melter on the furnace stage, subsequently attained great eminence in the steel industry.

Sir Arthur, who joined the Iron and Steel Institute in 1930, was made an honorary vice-president of the Institute in 1944. He was for a number of years a member of Council of the British Iron and Steel Federation and had served as a Searcher of the Cutlers' Company in Hallamshire. He was for several years chairman of the Alloy Steels Associa-

tion, a vice-president of the Sheffield Chamber of Commerce, and a Justice of the Peace for the City of Sheffield.

MR. ROBERT S. WHIPPLE.

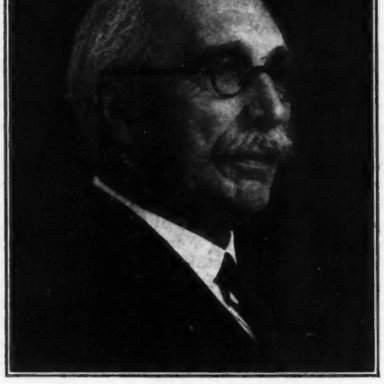
OUR readers, especially those who are particularly concerned with the use or manufacture of scientific nstruments, will share our deep regret at the death of Mr. Robert S. Whipple, which occurred at his home in Highgate on Sunday, December 13, at the age of 82. Mr. Whipple, who was for many years chairman of the Cambridge Instrument Company, Limited, may be said to have been born in an atmosphere of scientific instruments and to have spent his life among them; they were his main life interest, as well as his business.

Robert Stewart Whipple was born on August 1, 1871, his father, Mr. G. M. Whipple, being Superintendent of Kew Observatory. He was educated at King's College School, London, and entered Kew Observatory as an assistant in 1888, and remained there for eight years. He was then, for a short time, assistant manager to Mr. L. P. Casella and afterwards, in 1898, became private assistant to Mr. (later Sir) Horace Darwin, who founded the Cambridge Scientific Instrument Company in 1880. Whipple was made a joint managing director of the Company in 1909, and occupied this position until he retired in 1935. Shortly afterwards he was made chairman of the directors, which position he relinquished in 1949. He had a great influence on the development and use of instruments for laboratory and industrial use. His close connection with Professor H. L. Callendar, designer of the Callendar automatic self-balancing recorder, increased his appreciation of the need for accurate temperature measurement in industry and it is perhaps in this field that his efforts, during the first years of the century, were best known. He published many papers on this subject and lectured throughout the country, stressing the importance of temperature measurement by electrical means. He was the first to introduce the Féry radiation thermometer into this country. It was due to his foresight that he obtained for the Cambridge Company the sole right to manufacture this instrument in Great Britain and it continues to be made in much the same form as originally designed. He invented the Whipple temperature indicator, a sensitive highly accurate instrument for use with resistance thermometers, having a scale 18 ft. long in the form of a helical line on the surface of a drum 4½ in. in diameter. This instrument continues to be employed as a sub-standard in many large industrial undertakings and for calibration purposes.

Among the outstanding characteristics of Mr. Whipple were his unfailing interest and personal regard for his employees, by whom he was greatly revered. One of the activities that gave him the greatest satisfaction was when, as President of the Cambridge Chamber of Commerce, he was asked to arbitrate in a building strike that had for five months brought all building work in Cambridge to a standstill. He got the workers their union representatives and the employers together and in a few hours was able to arrange a settlement favourable to all parties. It was his keen sense of fairness, his patience and unfailing charm that was able to produce results when other methods of approach had failed. His death is a great personal loss to the older employees of the Cambridge Company, with whom he had always retained the closest association and whose interests he never failed to promote.

In addition to his life-long association with the Cambridge Instrument Company, he was twice President of the Scientific Instrument Manufacturers Association (SIMA), President of the Optical Society, treasurer of the Physical Society for 10 years and vice-president for three years. He was greatly interested in the British Association for the Advancement of Science, and was President of Section A (Mathematics and Physics) at the 1939 meeting in Dundee. This meeting, it may be remembered, was abandoned after a few days when the imminent outbreak of war occupied the minds of the members to the exclusion of all other matters. He gave the Faraday Lecture to the Institution of Electrical Engineers, of which he was a member, in the 1936-37 session, his subject being "Electricity in the Hospital." For 21 years he served on the board of the Institute of Physics, to which he made many benefactions.

The lifetime personal interest of Robert Whipple lay in the study and collection of old scientific instruments and books, and he amassed an extensive and valuable collection of great historical interest covering the Sixteenth and Nineteenth Centuries. With characteristic generosity this entire collection, with a sum of money, was presented to the University of Cambridge. Particulars of the most notable instruments and books in the collection will be found in an illustrated article on pages 161 and 223 of our 159th volume (1945). It was then stated that the collection would be stored until funds were available for the establishment of a Museum of the History of Science. This Museum was opened in 1951 and was appropriately named the Whipple Museum.



THE LATE MR. R. S. WHIPPLE.

He was greatly interested in the Royal Institution of Great Britain and served terms as both Visitor and Manager of this body. In 1938, he was elected president of the Highgate Literary and Scientific Institution in connection with which, only a month ago, he founded a charitable trust for the advancement of learning.

Apart from his authoritative knowledge of modern and historical scientific instruments and his numerous benefactions, Robert Whipple will long be remembered by all who had business or social contacts with him for the outstanding courtesy and kindness which characterised his relationships with others. His son, Mr. G. A. Whipple, is chairman and managing director of Hilger and Watts, Limited, who are also scientific instrument makers of high repute.

BOLDON AIRPORT SCHEME MAY BE ABANDONED.—It is not likely that the scheme for a major airport at Boldon, near Sunderland, will be proceeded with. The scheme, estimated to cost about 5,000,000*l.*, was proposed several years ago, but was postponed on the grounds of economy. The Ministry of Civil Aviation have now decided against the scheme, unless the cost is met by local authorities, in which case the Ministry would be prepared to service and staff the proposed airport. In a report to the North-East Airport Joint Committee, it is stated that the scheme would cost several millions of pounds and a deficit of 30,000*l.* annually might be expected.

ENERGY CONSUMPTION IN CANADA.

A RECENT "Commercial Letter," issued by The Canadian Bank of Commerce and entitled "Energy and Economic Development," provides information regarding the energy consumption in Canada over the quarter century extending from 1926 to 1952. In that period the total energy used, excluding that derived from wood, rose from the equivalent of 1,031,635 thousand million to 2,409,115 thousand million B.Th.U., or 133 per cent. The population increased by 50 per cent., so that the *per capita* consumption increased by 55 per cent. to a figure among the highest in the world. This has been reflected in economic development, but the high consumption is partly to be explained by the severity of the climate; it is estimated that in 1952, 28 per cent. of the total was "consumed in keeping warm." This percentage, however, includes an approximate figure for wood.

A diagram is given showing the contribution of each of the main sources of energy to the total. They are: water power, natural gas, Canadian petroleum, imported petroleum, Canadian coal and imported coal. It is realised that wood is also a source of energy, but no reliable data concerning it are available. It is estimated, however, that it may have contributed 7½ per cent. of the total in 1952. At the beginning of the period, in 1926, coal and coke were the sources of 82 per cent. of the energy; petroleum, 12·3 per cent.; natural gas, 2 per cent.; and water power, 3·7 per cent. In spite of the great extension in the use of petroleum products and the impressive water-power development, at the end of the period, in 1952, coal was still the largest contributor at 45 per cent., but it was rapidly being overtaken by petroleum which rose to 42 per cent. in that year; water power rose to 9 per cent. and natural gas to 4 per cent.

The striking increase in the use of petroleum products, which rose from 21·9 million barrels in 1926 to 172·4 million in 1952, began about 1940. It is attributed not only to the enormous development in the employment of the internal-combustion engine in its various forms, but also to extension of the use of oil for heating purposes. The use of oil in domestic stoves has increased sevenfold since 1940, and for industrial use, largely factory heating, the increase was threefold in the same period. Motor vehicles have been mainly responsible for the increased internal-combustion engine demand, registrations doubling between 1940 and 1952. Aircraft have also been an important factor in increasing consumption. The miles flown in 1952 were five times those in 1940.

Considerably more than half the coal used in Canada is imported, the relative proportions obtained from abroad and from home sources not varying greatly since 1940. During the war, oil, gas and electricity tended to replace coal and coke for domestic use and for transport, but there has been some recovery since, with a marked increase in the use of coal for electric generating stations. This has been mainly due to the new thermal power stations built by the Ontario Hydro-Electric Power Commission. Energy obtained from water power has shown a steadier and more continuous growth than any other form of production and, particularly in the domestic field, the demand is rising rapidly. Supplies for heating and other domestic purposes were four times greater in 1952 than in 1940.

Although natural gas occupies the lowest position among the sources of energy, it has long been of importance in Ontario, New Brunswick and parts of Alberta and Saskatchewan. The New Brunswick supply appears to be diminishing but that in Ontario has increased in recent years. In the western provinces, where the supply is potentially large, the market has been restricted to local areas of relatively small population, but with the construction of pipelines a greatly enlarged market will be opened up and natural gas may improve its position. Although it has not shown the same rate of advance as some other sources of energy, it has certainly made progress. Between 1940 and 1952 the proportional supply for domestic and heating purposes rose from 5·8 to 7·8 per cent., and for industrial purposes from 1·9 to 2·4 per cent.

COMMERCIAL-MOTOR MANUFACTURERS.

THE subject of the 9th Henry Spurrier Memorial Lecture, delivered in London on December 14 by Mr. Henry Spurrier, managing director of Leyland Motors, Limited, and a son of the man after whom the lecture is called, was road transport and the commercial-motor manufacturer. He opened his lecture by tracing briefly the history of transport and commercial-vehicle production—from the time when goods were conveyed in trucks drawn by man and beast, through the period when the steam engine was employed on the roads, to the present time, when petrol engines abounded and Diesel engines were coming into wider use. Although development of the internal-combustion engine began before 1900, and by then a number of vehicles driven by this new prime mover were in operation, he felt that this was really the date at which the motor industry could safely be considered to have found its feet, as all classes of commercial vehicles and motor cars were then in the process of manufacture.

Governments both past and present, he said, had plagued the motorist from the beginning. At first the law required vehicles to be preceded by a man carrying a red flag; this was abolished by the Act of 1896. No sooner, however, had vehicles shown signs of being numerous on the roads than taxation in one form or another was applied steadily and progressively by a succession of Chancellors of the Exchequer. The promise of good roads in return for the monies extracted was made, but these good intentions were never fulfilled. To-day, the motor industry was taxed higher than any other, with the least amount of contribution being made towards its improvement in return. He considered that taxation and the way in which it was imposed was creating a vehicle peculiar to this country, and if the past policies were pursued British motor products made for the home market would be of types entirely unique. This would make it necessary for the manufacturer to run side by side in production two totally different classes of vehicle, one for export and the other for home use.

Mr. Spurrier referred particularly to two classes of manufacturer: the one who builds vehicles by assembly of well-known makes of component parts, and the other whom he described as the manufacturing-operator. The main problems of the former were matching satisfactorily the different proprietary units and building these into a well-balanced vehicle, selling his product competitively, and at the same time ensuring that he was selling in the markets where arrangements were available for repairs and the supply of spare parts. This usually meant making a survey of his suppliers' servicing facilities in the country to which he wished to sell. In his favour, this type of manufacturer had the advantage of low overheads, as he was not obliged to carry large research and development staffs or spare-parts stores, assuming that the component suppliers were always abreast of modern developments. Mr. Spurrier said that it was within the last 25 years that these independent concerns had developed sufficiently to offer to the motor industry a full range of all major units. In the United States, however, the component manufacturer formed a large part of the automobile industry, and car and vehicle builders there undoubtedly enjoyed an enormous advantage in being able to choose from an extensive range of parts and to offer these in their own products to suit any condition. He expressed the fear that this class of manufacturer might eventually supersede the firm which to-day made and developed all the main items of the complete product with a full knowledge of what was expected of every part.

Regarding the manufacturing operators, who were few in number, it was much to their credit that they usually initiated and developed their own designs. Such a practice was, on the face of it, a costly exercise, but in practice it was usually undertaken by one company or section of a group of companies. Although (he said) he spoke with no knowledge on this subject, he thought that such an organisation must be staffed with competent designers who were kept fully informed of the practical difficulties of operators. More than one such manufacturing organisation of this type, he said, did in fact exist in this country and independent manufacturers might well have to face a serious situation were it not for the fact that these operator-designers developed and built vehicles only for their special needs.

Service and repair facilities he stressed as being foremost among the problems which faced the manufacturer when seeking export markets, and the organising of such facilities was a major undertaking. The staffing of overseas organisations often meant sending employees and their families abroad. His firm had tackled these problems and they had learnt one or two lessons of importance. First and foremost, arrangements for finding a home must be undertaken and, secondly, the appointment must never be made to look like a "life sentence," though the emigrants might well decide to stay.

Turning to the future and the trend of design he chose the public-service vehicle as being the most suitable type upon which to express his opinions. Three main parties were concerned: the public, the owner, and the driver and conductor. The public were concerned with the comfort and frequency of the service, the cost of the journey, and the length of time taken for the journey; the owner with the cost of operation, which alone covered a host of problems; and the driver and conductor with any improvement that made their daily task more simple. He claimed that the vehicle as seen to-day had very nearly reached the end of its useful life. "There are so many obvious improvements that ought to be capable of solution that it is a matter of time only before the answers are found."

The driver, he thought, had a heavy, tiring and relatively cumbersome conveyance to handle, and his work would be made easier by finger-light steering, and an infinitely-variable and fully-automatic transmission, coupled with single-pedal control. Smoother, and more powerful braking, and very much improved acceleration from rest would also help. The user would appreciate greater seating comfort, air conditioning, much improved springing, and, above all, a completely silent vehicle.

In the field of design, the manufacturer was also faced with the problem of producing vehicles which could be operated successfully on a variety of road surfaces, withstand temperatures ranging from 60 deg. below zero to 130 deg. F. in the shade and travel through all the known conditions of dust and varying humidity. He had therefore three distinct conditions of operation to cater for in his range of vehicles: a vehicle for the home market; an export vehicle to run on highways that were designed particularly for speed and to take heavy loads; and a vehicle to fulfil the conditions where actual performance was not so important as ensuring a large margin for structural reliability. The engine of the future, he forecast, would be one having only rotating masses, which would almost certainly reduce the vibration. A development of the present gas turbine was probably the answer. The sort of development he visualised might well open up a new field in the possibility of employing the kinetic energy of a heavy rotating mass through which a vehicle would be accelerated and braked without the present high degree of power being wasted as it is through excessive frictional losses.

The task of developing such features was formidable. The thermal efficiency of the gas turbine would require raising by 200 to 300 per cent. before it could be considered for general use. Also, the answer to a simple variable gear or power transmitter must be found. These problems were all capable of solution, but the date of their solution would depend on the weight of technical research that could be applied. The more simple problems, however, such as improved springing, greater stability, air conditioning, non-glare lighting, etc., should almost certainly be incorporated many years before the more revolutionary changes.

PRODUCER-GAS DEVELOPMENT.—A new type of gas producer installed at the River Don Works, Sheffield, of the English Steel Corporation Ltd., is capable of making 25,000,000 cub. ft. of gas each week for reheating and heat-treatment furnaces. The much cleaner type of gas obtained from the new producer ensures a better degree of furnace control. The plant has been installed by the International Furnace Equipment Co. Ltd., Aldridge, Staffordshire.

THE INSTITUTION OF WATER ENGINEERS.

AT a meeting of the Institution of Water Engineers held in London on December 4, three papers were presented dealing, respectively, with stratification and "overturn" in lakes and reservoirs, the reduction with age of the carrying capacity of pipelines, and the construction of a bore-hole in an unconsolidated formation using a graded filter.

STRATIFICATION AND "OVERTURN" IN LAKES AND RESERVOIRS.

The phenomena known as "stratification" and "overturn" are of fundamental importance for an understanding of the biological behaviour of large masses of water, whether in the form of natural lakes or man-made reservoirs. They were the subject of a paper entitled "Stratification and Overturn in Lakes and Reservoirs" presented by Mr. R. W. S. Thompson, M.I.C.E. The primary causes of thermal stratification are the temperature-density relationship peculiar to water, its low thermal conductivity and the very limited penetration of radiant light and heat.

Since water has its maximum density at 4 deg. C., the greater the departure from this temperature the greater are the forces per degree of temperature difference which cause water to float to the surface or to sink, and, therefore, the greater the stability of stratification. This stratification of water into layers can result in the *hypolimnion*, or lowest layer, which may extend from the bottom of a lake or reservoir to about 60 per cent. of the total depth, stagnating for months at a time during the warmer period of the year. In such conditions of stagnation, the bottom water can become completely de-oxygenated when anaerobic decomposition takes place. This decomposition will then continue until overturn occurs with the change of season later in the year: the cooled surface water becomes denser and, therefore, sinks, its place being taken by warmer water from the lower layers. Once a lake or reservoir has "overturned" and circulation has been restored, the condition of oxygen deficiency soon ceases and those bacteria which can break down organic substances by oxidising processes largely replace those that operate by reduction, with a consequent increase in the formation of nitrates. At the time of the Spring overturn, when there is a diffusion of plant nutrients, the increasing strength of the sun causes an out-burst of algal growths which, in the case of Lake Windermere, is predominantly the plankton diatom *Asterionella*. In his conclusions the author pointed to the desirability of having outlets arranged at different levels to be used according to the season so that the drawing-off into the water-supply mains of algae and the stagnant de-oxygenated water of the *hypolimnion* may be avoided.

CARRYING CAPACITY OF PIPELINES.

In a paper entitled "The Reduction with Age of the Carrying Capacity of Pipelines" Mr. Peter Lamont, M.A., A.M.I.C.E., considered the rate of growth of roughness and the consequent reduction in discharge of old cast-iron pipes in relation to the chemical and biochemical characteristics of the water, and also the rate of growth of roughness and the consequent reduction in discharge of spun lined pipes affected by slime, silt and vegetable growths. He recommended allowances to be made in design for age effects in cast-iron and spun lined mains, and compared the costs and relative carrying capacities, after various periods of service, of spun iron and spun-concrete lined pipes. In his conclusions, the author intimated that spun-concrete lined pipes gained an increasing economic advantage over spun-iron pipes as the size of the pipes and the corrosive power of the water increased, but that the choice available to the water-supply engineer was likely to be wider in the future, as it was possible that technical developments would result in the production of pipes, made of a plastic or lined with that or other new materials, which would enjoy even greater immunity from age effects.

GRADED FILTER FOR A BORE-HOLE.

The third paper, by Mr. R. J. Bell, A.M.I.C.E., was entitled "Construction of a Bore-hole in an

Unconsolidated Formation using a Graded Filter," and in it he described the sinking of a bore-hole to a depth of 260 ft. and the packing of the annular space between the natural water-bearing strata and the internal slotted lining so as to provide a filter. The bore-hole was sunk through 69 ft. of gault, 172 ft. of the Folkstone beds, and 9 ft. of the Sandgate beds into the Hythe beds, and was given a slotted steel lining 24 in. in diameter. The slots in the lining were ¼ in. wide and the annular filter consisted of Bridport pea-gravel of sizes ranging from ½ in. to ⅛ in., mixed with a local sand the particle sizes of which generally corresponded with those of the sands encountered during sinking, excepting where two bands of silt occurred. To prevent the entry of this silt, the slots in the corresponding sections of the slotted pipe were blanked-off. The filter was poured through 3-in. diameter pipes, placing proceeding from the bottom upwards in rises of 9 in., a small amount of water being used as a lubricant. Since 60 per cent. of the material comprising the filter, and all the natural sand encountered, could pass through the ½-in. slots, the development of the bore-hole was carefully controlled and watched. The total quantity of sand pumped through and deposited in the surge and weir tanks was only 28⅞ cub. ft., of which 18 cub. ft. were deposited during the first 7 days and ⅛ cub. ft. during the last 4 days of pumping.

The yield/water-level curve approximated to a straight line over much of its length, yields of 18,000 gallons and 34,000 gallons an hour corresponding to figures of draw-down of 45 ft. and 97 ft., respectively. The author concluded that the use of a graded filter in the construction of a bore-hole in an unconsolidated formation had definite advantages over other methods, and that as the quantity of sand pumped was very small and did not increase with increased output from the bore-hole, pumping could be carried out to capacity, so obviating the practice of reducing the output to diminish the in-flow of sand.

"WATER-FOG" EQUIPMENT UNDER ESCALATORS.

THE considerable quantity of fine dust and fluff which collects under London Transport's escalators not only impedes maintenance work but also presents a fire risk, since it could be ignited, in certain circumstances, by a dropped cigarette or burning match. To overcome this risk, many escalators have recently been fitted with spraying equipment which consists of a series of nozzles arranged in pairs at intervals of approximately 4 ft. They are supplied from a central main conveying water at 50 lb. per square inch and are arranged below the stair treads over the total length of an escalator. The nozzles emit a very fine spray which rapidly penetrates to every part of the mechanism below the treads.

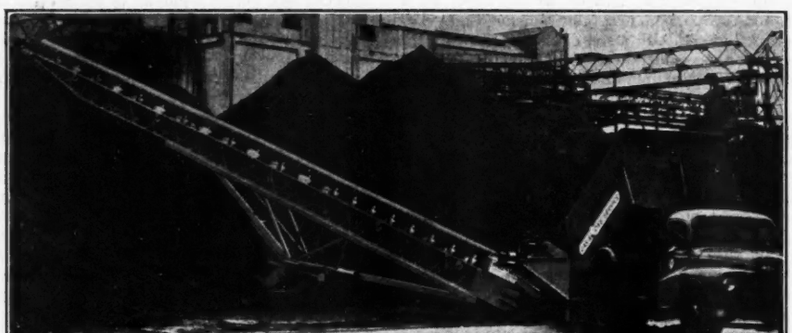
If smouldering occurs or fire breaks out, it can be extinguished immediately by the station staff before any serious damage is done. The equipment can also be used for the routine removal of dust and fluff which builds up under the stair treads at different rates depending on local conditions; where this build-up occurs most rapidly, it has been found sufficient to give treatment as infrequently as once every three weeks.

The duration of treatment is extremely short, half a minute only being found sufficient to dislodge accumulations of fluff, and since the mechanism is automatically lubricated, there is no ill-effect from an application of such short duration. This system assists in maintaining escalators in a satisfactory condition, and lengthens the intervals between cleaning by hand.

LINCOLN AND MEXBOROUGH POWER STATIONS.—The British Electricity Authority have received the consent of the Minister of Fuel and Power to the extension of the Lincoln and Mexborough power stations. Two 20MW turbo-generator sets and four boilers, each having an evaporative capacity of 120,000 lb. of steam an hour, will be installed at Lincoln, bringing the installed capacity of the station up to 86 MW. At Mexborough, the new installation will consist of two 30 MW turbo-generator sets and three boilers, each having an evaporative capacity of 180,000 lb. of steam an hour, increasing that station's installed capacity to 120 MW.

STOCKPILING AND LOADING EQUIPMENT.

C. H. JOHNSON (MACHINES), LTD., STOCKPORT.



STOCKPILING AND LOADING EQUIPMENT.

FOR stockpiling coke to a height of 27 ft. at a high rate directly from a lorry, the North Western Gas Board are employing at their Birkenhead gas works two mobile machines, a 62-ft. Hylo-veyor and a Loband loader, both of which are manufactured by C. H. Johnson (Machines), Limited, Adswood-road, Stockport; the equipment is shown in the accompanying illustration. With this combination, coke can be handled at rates up to 100 tons per hour.

The Loband loader, designed for use with end-tipping lorries, comprises a large receiving hopper delivering on to a stacking conveyor, the frame being mounted on two pneumatic road wheels. The hopper, into which the lorry discharges directly, has an end opening 9 ft. 3 in. wide by 1 ft. 11½ in. high. It is protected against spillage by a 6-in. deep rubber apron across the opening and vertical anti-spill plates attached to each of the side plates. The tailboard of the lorry is supported by an adjustable bar spanning the spill plates. The flow of material from the hopper on to the conveyor is controlled by an adjustable throat plate. The conveyor comprises a three-ply rubber-and-canvas belt 24 in. wide, running on ball-bearing sealed idlers. The drums are at 14-ft. centres, and the discharge height is 4 ft. 7 in. to the centre of the drum. Both drums are mounted in self-aligning ball bearings, and the lower-bearing brackets can be adjusted to maintain the belt tension. The top drum is self-cleaning. Three drive units are available—a 6-h.p. 1,500-r.p.m. totally-enclosed squirrel-cage motor, a twin-cylinder air-cooled Petters AVA2 Diesel engine, or a twin-cylinder air-cooled Petters PA2 petrol engine; both the latter have built-in clutches. The drive to the top drum is through a totally-enclosed Hardy-Spicer shaft to a worm-reduction gear, flexibly coupled to the top drum shaft. The belt speed is 300 ft. per minute.

For heavy duty, such as handling large lumps of ore, a special hopper and belt and shock-absorbing idlers can be supplied. The loader can also be used for loading barges from lorries by fitting slewing wheels and a longer boom; and by fitting additional plates to the hopper it can be used in conjunction with a bulldozer for recovery from a stockpile.

The Hylo-veyor machine incorporates a self-contained elevating unit which eliminates the type of undercarriage usually associated with a large portable conveyor. The boom consists of standard head and tail sections, with 6-ft. and 8-ft. intermediate sections, and can be built up into various lengths between the drum centres. The elevating unit, attached to the underside of the conveyor boom in such a position that approximately two-thirds of the conveyor length is on the discharge side, consists of a frame in which are mounted a single-ram 7-ton or 10-ton hydraulic jack, the hydraulic tank, and a manually-operated pump. The jack is anchored by a sturdy support at the rear of the base frame, and the ram is connected to a lever keyed to the main elevator shaft spanning the frame, which is supported in large bearings. The shaft is extended beyond the bearings on each side, and on these extensions are mounted the undercarriage legs which carry the axle on which are the two main wheels. When the elevating ram is extended by the hand pump, the legs are forced downwards and the boom is raised. When the desired height has been reached, the ram can be locked against the jack cylinder by a loose collar and pin, thus preventing "creep-back" under load. Lowering of the boom is accomplished by removing the locking pin and opening a relief valve on the hydraulic tank.

The conveyor belt can be driven by either a 4½-h.p. or a 6-h.p. air-cooled petrol or Diesel engine, or by a 4-h.p. or 6-h.p. totally-enclosed squirrel-cage motor. The drive unit is carried on a platform attached to the tail section of the boom, and the drive is transmitted to the conveyor drum, which is of the self-cleaning type, through a Hardy-Spicer shaft and a fan-cooled worm-reduction unit, which is flexibly coupled to the drum shaft. The latter is supported in self-aligning ball-bearing plummer blocks. The four-ply belt runs on Johnson ball-bearing troughed idlers. If desired, the belt can be fitted with angle flights. Belt-tensioning gear is fitted to the head section. The feed hopper is hinged at the back and secured by four knurled screws, so that it can be easily disconnected and swung back for cleaning. Alternative hoppers for loading by power shovel, or mobile hoppers, are also made.

ELECTRICITY SUPPLY STATISTICS.—During November, 1953, 5,555 million kWh were sold by the British Electricity Authority to the Area Boards, an increase of 2·3 per cent. over the output in the same month of last year. When corrected for the weather and the number of working days, the increase was, however, 8 per cent., the weather having been much warmer and the number of working days having been higher. The amount of electricity sent out by the Area Boards during the month was also 5,555 million kWh. Supplies to the "mainly industrial" areas, however, increased by 3·7 per cent., while those to the "mainly non-industrial" areas fell by 0·9 per cent.

SECOND PRODUCTION LINE FOR "BRITANNIA" AIR LINERS.—The Bristol Aeroplane Co., Ltd., Filton House, Bristol, and Short Brothers & Harland Ltd., Queen's Island, Belfast, have entered into an agreement for the latter Company to prepare capacity at their Belfast Works for producing Bristol Britannia aircraft. This programme supplements that already arranged at the Bristol Aeroplane Company's own works at Filton, Bristol. The agreement between the Bristol Aeroplane Co., Ltd., and Short Brothers & Harland Ltd., follows only a week after the announcement of the Canadian government's decision that Canadair Ltd., Montreal, is to proceed with a version of the Britannia aircraft for the use of the Royal Canadian Air Force.

BRITISH CELEBRATION OF THE WRIGHT JUBILEE.

AMONG the various exhibitions, lectures and celebrations arranged to commemorate the 50th anniversary of the first controlled and sustained flight in a heavier-than-air craft, probably the most memorable was the dinner held jointly by the Royal Aeronautical Society and the Royal Aero Club at the Dorchester Hotel, London, on Thursday, December 17. The dinner was followed by the first public showing of a film entitled "Powered Flight, the Story of the Century," produced by the Film Unit of the Shell Petroleum Company, Limited, with the co-operation and technical guidance of the Royal Aeronautical Society. The film reviews the progress of aeronautics during the 50 years that have elapsed since Orville Wright made the first successful flight in the Wright Flyer. There were, naturally, no cinematographers present on that occasion, but the film includes some scenes taken five years later, with Wilbur Wright at the controls of his demonstration machine in Europe.

Other interesting early events shown in the film are Blériot's first crossing of the English Channel in 1909, and the Sopwith floatplane, piloted by Howard Pixton, which won the Schneider Trophy in 1914, which was the first time that Great Britain had entered the contest. The rapid development of the military aeroplane in the first world war, the great pioneering flights by such men as Alcock and Brown, Kingsford Smith and Lindbergh, the beginnings of commercial air transport, and the light aeroplane movement are all depicted. The Schneider Trophy victories in 1927, 1929 and 1931, which led to the concept of the Spitfire, are shown and the part played by that aircraft in the second world war is outlined in some detail. During the war, the jet aircraft made its appearance, and the film brings out clearly the rapidity with which the configuration of aircraft has changed during the last 10 years as a result of jet propulsion.

An exhibition at the Science Museum, which opened on Tuesday, December 15, and is to remain open for three months, deals mainly with the Wright Brothers' activities and events leading up to them, and includes a number of photographs of their gliders and powered machines, together with replicas of the revolution indicator, stop watch and distance recorder used on their first flight, and of the 0·33-gallon fuel tank of the Wright Flyer. Among the historical exhibits, one of the most interesting is Stringfield's original steam engine and boiler for a model aircraft, shown at the Crystal Palace exhibition in 1867; and among the literary exhibits, Sir George Cayley's notebook (published for the Newcomen Society) is of particular interest. Literary exhibits of Hargreaves' work on box kites, Sir Hiram Maxim's work, and Lilienthal's observations on bird flight, are also on view, together with descriptive works on early attempts to fly.

Another notable event of the jubilee week was a lecture given by Captain J. Laurence Pritchard, on "The Work of the Wright Brothers for Aviation," to the Royal Society of Arts in London on Wednesday, December 16. At the time the Wrights commenced their experiments, Captain Pritchard said, they were young enough not to be deterred by failures. Whereas many observers must have studied bird flight, none but the Wrights had been able to interpret and make use of it. Their wind-tunnel work was an inspiring example of the simple research methods of genius. In twelve months they designed and constructed their own engine, their own propellers, and the aeroplane itself, predicted its performance, and finally flew it to schedule. With only a general education, they taught themselves the necessary mathematics and mechanics.

After describing their gliding experiments, the first flight, and the belated recognition of their success, Captain Pritchard's lecture, as preprinted concluded with an account of the extraordinary action of the Smithsonian Institution which led to the 1903 Flyer being housed in the British Science Museum for 20 years. In 1903, Dr. S. P. Langley, then secretary of the Smithsonian Institution, built a man-carrying aircraft and two unsuccessful attempts were made to launch it; in both cases it collapsed, and Langley, who died in 1906, attributed the failure to the launching apparatus. He was succeeded at the Smithsonian Institution by Dr. Walcott. In 1914, Griffith Brewer, of the Royal Aeronautical Society, when visiting the Institution, learned that Langley's full-size machine was being tested at Hammondsport by Glenn Curtiss. Brewer visited Hammondsport and observed that the machine had been structurally and aerodynamically modified. The Institution, however, claimed that the Langley machine had been flown without modification and that Langley "had succeeded in building the first aeroplane capable of sustained free flight with a man." Owing to the first world war, it was not until 1921 that Griffith Brewer was able to call public attention to the alterations made to Langley's machine by officials of the Institution in a paper on "The Langley Machine and the Hammondsport Trials," given before the Royal Aeronautical Society, and it was on his suggestion that Orville Wright sent the 1903 machine to England, in 1928, for exhibition in the Science Museum. Dr. Walcott died in 1927, and it was not until 1942 that his successor, Dr. Abbot, agreed to retract in public the claims the Institution made for Langley's machine. In 1948, the Wright machine was returned to the Smithsonian Institution after the death of both Orville Wright and Griffith Brewer earlier that year.

FORTHCOMING EXHIBITIONS AND CONFERENCES.

THIS list appears in the last issue of each month. Organisers are invited to send to the Editor particulars of forthcoming events.

BIRMINGHAM CLOCK AND WATCH EXHIBITION.—Friday, October 30, to Sunday, February 28, 1954, at the Birmingham Museum of Science and Industry, Newhall-street, Birmingham, 3. See also page 605, *ante*.

WRIGHT AERONAUTICAL EXHIBITION.—Thursday, December 17, to mid-March, 1954, at the Science Museum, South Kensington, London, S.W.7. (Telephone: KENsington 6371.) See also page 756, *ante*.

TELEVISION EXHIBITION.—Thursday, Friday and Saturday, January 7, 8 and 9, 1954, at King's College, Strand, London, W.C.2. Not open to the general public on January 7. Organised by the Television Society. Admission tickets obtainable gratis from the secretary of the Society, 164, Shaftesbury-avenue, London, W.C.2. (Telephone: TEMple Bar 3330.) See also page 685, *ante*.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, GENERAL MEETING.—Wednesday, January 13, to Wednesday, January 20, 1954, in Canberra. Apply to Professor A. H. Corbett, Royal Military College, Duntroon, A.C.T., Australia.

INTERNATIONAL EXHIBITION ON LOW-COST HOUSING.—Wednesday, January 20, to Friday, March 5, 1954, at the Old Fort, New Delhi, India. Organised by the Ministry of Works, Housing and Supply of the Government of India. Apply to the Director of the exhibition, "P" Block, New Delhi, India.

CANADIAN CONFERENCE ON PRESTRESSED CONCRETE.—Thursday and Friday, January 28 and 29, 1954, in Toronto. Further particulars obtainable from Mr. H. Fealdman, secretary, organising committee, Canadian Conference on Prestressed Concrete, Hydro-Electric Power Commission of Ontario, 620, University-avenue, Toronto 2, Canada.

FOURTH NATIONAL POWER FARMING CONFERENCE.—Tuesday, Wednesday and Thursday, February 9, 10 and 11, 1954, in the Town Hall, Cheltenham. Organised by the *Power Farmer: Britain and Overseas*, Dorset House, Stamford-street, London, S.E.1. (Telephone: WATerloo 3333.)

SYMPOSIUM ON OIL FILTRATION IN MODERN INDUSTRY.—Thursday and Friday, February 11 and 12, 1954, at the Business Administration and Economics Building, University of California, Los Angeles. Organised by the Department of Engineering of the University, in co-operation with the American Society of Lubrication Engineers. Further information obtainable from the Engineering Extension, University of California, 3076 Engineering Building, Los Angeles 24, California, U.S.A. See also page 360, *ante*.

BUSINESS EFFICIENCY EXHIBITION.—Tuesday, February 23, to Friday, February 26, 1954, at the Drill Hall, Fenton-street, Leeds. Organised by the Office Appliance and Business Equipment Trades Association, 11-13, Dowgate-hill, Cannon-street, London, E.C.4. (Telephone: CENtral 7771.)

IDEAL HOME EXHIBITION.—Tuesday, March 2, to Saturday, March 27, 1954, at Olympia, London, W.14. Organised by Associated Newspapers, Ltd., New Carmelite House, London, E.C.4. (Telephone: CENtral 6000.)

INTERNATIONAL AGRICULTURAL MACHINERY EXHIBITION.—Tuesday, March 2, to Sunday, March 7, 1954, at Paris. Organised by the Salon International de la Machine Agricole, 95, Rue Saint Lazare, Paris, 9e.

CANADIAN NATIONAL SPORTSMEN'S SHOW.—Friday, March 12, to Saturday, March 20, 1954, at the Coliseum, Toronto. Exhibition of motor-cars, motor-cycles, motor boats and ancillary equipment. British section. Additional information obtainable from the Society of Motor Manufacturers and Traders, 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

34TH VIENNA SPRING TRADE FAIR.—Sunday, March 14, to Sunday, March 21, 1954, at Vienna. Apply to the British-Austrian Chamber of Commerce, 29, Dorset-square, London, N.W.1. (Telephone: PADdington 7646.)

THIRD ELECTRICAL ENGINEERS' EXHIBITION.—Tuesday, March 16, to Saturday, March 20, 1954, at Earl's Court, London, S.W.5. Organised by the Association of Supervising Electrical Engineers, 54, Station-road, New Barnet, Hertfordshire. Apply to Mr. P. A. Thorogood, 35, Gibbs Green, Edgware, Middlesex. (Telephone: MILl Hill 3528.)

CHEMICAL ENGINEERING IN THE FOOD INDUSTRY CONFERENCE.—Thursday and Friday, March 18 and 19, 1954, at Wellcome Research Institution, 183-193, Euston-road, London, N.W.1. Organised by the Food Group of the Chemical Engineering Group. Apply to the assistant secretary, Society of Chemical Industry, 56, Victoria-street, London, S.W.1. (Telephone: VICtoria 5215.)

SECOND FACTORY EQUIPMENT EXHIBITION.—Monday, March 22, to Friday, March 26, 1954, at the two halls of the Royal Horticultural Society, in Vincent-square and Greycoat-street, London, S.W.1. Apply to Mr. J. E. Holdsworth, 117, Kingsway, London, W.C.2. (Telephone: HOLborn 1414.) See also page 218, *ante*.

AMERICAN CHEMICAL SOCIETY, NATIONAL MEETINGS.—Wednesday, March 24, to Thursday, April 1, 1954, at Kansas City, Missouri, U.S.A.; and Sunday, September 12, to Friday, September 17, 1954, at New York. Organised by the American Chemical Society, 1155, Sixteenth-street N.W., Washington 6, D.C., U.S.A.

STOCKHOLM MOTOR SHOW.—Friday, March 26, to Sunday, April 4, 1954, at Stockholm. Organised by St. Eriksmassan A/B., Lidingovagen 10, Stockholm, Sweden.

CONFERENCE ON THE YOUNG WORKER: EDUCATION FOR HUMAN RELATIONS.—Saturday, April 3, to Friday, April 9, 1954, at Manchester College, Oxford. Particulars obtainable from the secretary, Conference on the Young Worker, 15, Norham-gardens, Oxford. (Telephone: Oxford 58631.) See also page 660, *ante*.

SYMPOSIUM ON GAS ABSORPTION.—Monday, Tuesday and Wednesday, April 5, 6 and 7, 1954, at Birmingham. Organised by the Midlands Branch, Institution of Chemical Engineers. Further information obtainable from the secretary of the Institution, 56, Victoria-street, London, S.W.1. (Telephone: VICtoria 6161.)

CONFERENCE ON THE PHYSICS OF PARTICLE SIZE ANALYSIS.—Tuesday, April 6, to Friday, April 9, 1954, at Nottingham University. Organised by the Institute of Physics, 47, Belgrave-square, London, S.W.1. (Telephone: SLOane 9806.)

PHYSICAL SOCIETY'S EXHIBITION.—Thursday, April 8, to Tuesday, April 13, 1954, at the Royal College of Science main building, Imperial Institute-road, South Kensington, London, S.W.7. Organised by the Physical Society, 1, Lowther-gardens, London, S.W.7. (Telephone: KENsington 0048.)

LIÉGE INTERNATIONAL FAIR.—Saturday, April 24, to Sunday, May 9, 1954, at Liége, Belgium. Apply to the manager, Foire Internationale de Liége, 17, Boulevard d'Avroy, Liége, Belgium. See also page 218, *ante*.

HANOVER LIGHT AND HEAVY INDUSTRIES FAIR.—Sunday, April 25, to Tuesday, May 4, 1954, at Hanover. *Agents:* Schenkers, Ltd., 27, Chancery-lane, London, W.C.2. (Telephone: CHAncery 6612.)

ROYAL SANITARY INSTITUTE HEALTH CONGRESS.—Tuesday, April 27, to Friday, April 30, 1954, at Scarborough. Apply to the secretary of the Institute, 90, Buckingham Palace-road, Westminster, London, S.W.1. (Telephone: SLOane 5134.)

FOURTH INTERNATIONAL PAPER, PRINTING AND ALLIED TRADES EXHIBITION.—Saturday, May 1, to Wednesday, May 12, 1954, at the Grand Palais, Champs Elysées. Organised by the Salon des Techniques Papetières et Graphiques, 40, Rue du Colisée, Paris, 8e.

BRITISH INDUSTRIES FAIR.—Monday, May 3, to Friday, May 14, 1954, at Earl's Court, London, S.W.5; Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars obtainable from the director, British Industries Fair, Board of Trade, Lacon House, Theobald's-road, London, W.C.1. (Telephone: CHAncery 4411); or

from the general manager, British Industries Fair, 95, New-street, Birmingham, 2. (Telephone: Midland 5021.)

OXIDATION CONFERENCE.—Thursday and Friday, May 6 and 7, 1954, at The Hague. Organised by the Institution of Chemical Engineers, the Chemical Engineering Group, the Netherlands Chemical Society and the Koninklijk Instituut van Ingenieurs. Additional particulars obtainable from the secretary, British organising committee, Institution of Chemical Engineers, 56, Victoria-street, London, S.W.1. (Telephone: VICtoria 6161.)

SYMPOSIUM ON MIX DESIGN AND QUALITY CONTROL OF CONCRETE.—Tuesday, Wednesday and Thursday, May 11, 12 and 13, 1954, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Further particulars obtainable from the secretary, the Cement and Concrete Association, 52, Grosvenor-gardens, London, S.W.1. (Telephone: SLOane 5255.) Alteration of dates. See also page 108, *ante*.

FOURTH GAUGE AND TOOL EXHIBITION.—Monday, May 17, to Friday, May 28, 1954, in the New Hall of the Royal Horticultural Society, Elverton-street, Westminster, London, S.W.1. Organised by the Gauge and Tool Makers' Association, Standbrook House, Old Bond-street, London, W.1. (Telephone: HYDe Park 3451.)

CANADIAN INTERNATIONAL TRADE FAIR.—Monday, May 31, to Friday, June 11, 1954, at Toronto. Apply to Miss M. A. Armstrong, Canadian Government Exhibition Commission, Canada House, Trafalgar-square, London, S.W.1. (Telephone: WHItehall 8701.)

FOURTH MECHANICAL HANDLING EXHIBITION.—Wednesday, June 9, to Saturday, June 19, 1954, at Olympia, London, W.14. Organised by *Mechanical Handling*, Dorset House, Stamford-street, London, S.E.1. (Telephone: WATerloo 3333.)

CONFERENCE ON CIVIL ENGINEERING PROBLEMS IN THE COLONIES.—Monday, June 14, to Friday, June 18, 1954, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Apply to the secretary of the Institution at that address. (Telephone: WHItehall 4577.) See also page 87, *ante*.

BUILDING PLANT EXHIBITION.—Thursday, June 24, to Wednesday, June 30, 1954, at Hills Meadow, Reading. Organised by the Ministry of Works. Apply to the acting chief information officer, Room 117, Lambeth Bridge House, London, S.E.1. (Telephone: RELiance 7611.)

ROYAL SHOW.—Tuesday, July 6, to Friday, July 9, 1954, at Windsor. Organised by the Royal Agricultural Society of England, 16, Bedford-square, London, W.C.1. (Telephone: MUSeum 5905.)

LAUNDRY, DRY CLEANING AND ALLIED TRADES EXHIBITION.—Thursday, July 8, to Saturday, July 17, 1954, at Olympia, London, W.14. Organisers: F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHItehall 0568.)

CONFERENCE ON DEFECTS IN CRYSTALLINE SOLIDS.—Tuesday, July 13, to Saturday, July 17, 1954, at the H. H. Wills Physical Laboratory, Royal Fort, Bristol, 8. Organised in conjunction with the Institute of Physics. Further particulars may be obtained from the secretary of the Laboratory; or the secretary, Institute of Physics, 47, Belgrave-square, London, S.W.1. (Telephone: SLOane 9806.)

GREAT YORKSHIRE AGRICULTURAL SHOW.—Tuesday, July 13, to Thursday, July 15, 1954, at Harrogate. Organised by the Yorkshire Agricultural Society, Great Yorkshire Showyard, Hookstone-drive, Harrogate. (Telephone: Harrogate 6014.)

RADIOISOTOPE CONFERENCE.—Monday, July 19, to Saturday, July 24, 1954, at Oxford. Arranged by the Atomic Energy Research Establishment, Harwell. Further details obtainable from the conference secretary, A.E.R.E., Harwell, Didcot, Berkshire. (Telephone: Abingdon 620.)

WORLD POWER CONFERENCE, SECTIONAL MEETING.—Sunday, July 25, to Sunday, August 8, 1954, at Rio de Janeiro, Brazil. Applications should be sent to the secretary, British National Committee, World Power Conference, 201-2, Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHItehall 3966.)

NATIONAL RADIO AND TELEVISION EXHIBITION.—Wednesday, August 25, to Saturday, September 4, 1954, at Earl's Court, London, S.W.5. Organised by the Radio Industry Council. Apply to the secretary of the Council, 59, Russell-square, London, W.C.1. (Telephone: MUSeum 6901.)

SCOTTISH INDUSTRIES EXHIBITION.—Thursday, September 2, to Saturday, September 18, 1954, at the Kelvin Hall, Glasgow. Apply to the offices of the exhibition, 16, Woodside-terrace, Glasgow, C.3. (Douglas 8811.)

FIRST INSTRUMENT CONGRESS AND EXPOSITION.—Monday, September 13, to Friday, September 24, 1954, in the Commercial Museum and Conference Hall, Philadelphia. Sponsored by the Instrument Society of America Apply to the manager, Mr. Richard Rimbach, 845, Ridge-avenue, Pittsburgh 12, Pennsylvania, U.S.A.

LABOUR NOTES.

CHEERING news that the anticipated strike over the railway-wage dispute would not take place after all were announced on December 16. After four days of intensive negotiations, in which the efforts of Sir Walter Monckton, the Minister of Labour, officials of the three principal railway unions, and representatives of the British Transport Commission were all needed to secure agreement, the executive committee of the National Union of Railwaymen stated that strike instructions sent to its branches on December 12 had been cancelled. The projected national strike of the members of the N.U.R., as from 12.01 a.m. on December 21, was also discussed at meetings of the cabinet. With all these discussions, however, the settlement was not reached easily.

Difficulties commenced when the three principal railway unions, the N.U.R., the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association, at a joint meeting on December 10, rejected the wage increase of 4*s*. a week, which had been awarded to their members by the Railway Staff National Tribunal on December 4. The unions had asked for an increase of 15 per cent. all round. Although it had previously declined to make any wage concession, the Commission accepted the Tribunal's award shortly after its terms were announced. Later, the A.S.L.E.F. passed a strike resolution, but negotiations between the men's leaders and the Commission continued on December 11 and 12.

In connection with these negotiations, an offer was made by the Commission on December 12 to examine with the three unions the whole wage and salary structure of the industry, to correct anomalies, and to provide further incentives; it being a condition of this offer that the unions would accept the Tribunal's award of 4*s*. a head. The A.S.L.E.F. and the T.S.S.A. agreed to accept the Commission's offer as the basis for further negotiation, but the N.U.R. declined to accept, and decided to call a national strike of its members. The executive committee of the T.S.S.A. then announced that they would recommend their members to stay at work even if members of the N.U.R. withdrew.

As a result of the further negotiations, following the N.U.R. strike threat, the Commission added the further promise that within two months from December 4, the date of the Tribunal's award, a further improvement on the standard rates of pay would be made, on a percentage basis. It was on this understanding that the N.U.R. withdrew its strike notices. From the foregoing, it appears that the wage improvements in the industry will come into force in three stages: the 4*s*. increase awarded by the Tribunal, and eventually accepted by both sides, takes effect immediately; the percentage increase, including the 4*s*. award, will be brought into operation during the coming five weeks; and, finally, the whole wage structure will be reviewed, anomalies corrected, and incentives improved in the near future.

After the concluding meeting on December 16, Mr. J. S. Campbell, the general secretary of the N.U.R., said that his union had warned the Commission that any percentage increase which gave the lowest-paid railwaymen less than 7*s*. a week more than they were then receiving would not be accepted. Mr. Campbell added that it had been estimated that an increase of 5 per cent. in wages would cost the Commission about 13 million pounds in a full year. An advance of 7*s*. for the lowest-paid railwaymen only would be equivalent to about 6 per cent. on wage rates, so that that might reasonably be expected to cost the Commission between 15 and 16 million pounds a year. The removal of anomalies and the addition of incentives, when the wage structure came to be revised, would increase the Commission's annual wage bill still further. In short, relief that the present season will not be marred by a major industrial dispute may well be tempered by the feeling that payment, in the form of higher passenger fares and increased goods freights, is yet to come.

Shop stewards in the employ of the Standard Motor Company, Limited, Coventry, are to have their activities restricted. The management of the company notified the Coventry district committee of the Confederation of Shipbuilding and Engineering Unions, on December 15, that this action had been taken as a result of its 12,000 workpeople participating in the 24-hour token strike in the engineering industry on December 2. In a statement issued to every employee, the firm declared that, from the many expressions of disagreement with the strike action, which had been received from its workpeople, the company had concluded that the strike action was not unanimous. As the shop stewards were the elected representatives of the employees, and their election was in the main by secret ballot, the company had had to assume that the decision communicated to it by the trade-union shop stewards, that strike action was to be undertaken, represented the views of the majority of its employees.

Confidence by the company in its co-operation with the trade unions, to provide good working conditions for its employees, had been seriously undermined by what the company considered to be irresponsible action. As, however, the company recognised the vitally important part that the trade unions must play in industrial matters, and therefore in the economic affairs of the nation, it desired to re-establish confidence and co-operation with the unions at the earliest opportunity. With immediate effect, all shop stewards would be required to undertake the duties for which they were employed and for which the company paid.

The Standard Motor Company concluded its statement to its employees by saying that it was satisfied that the facilities provided would be amply sufficient to enable proper trade-union activities to be carried out, and for employees to be fully represented in all matters affecting themselves or the company. Employees of the company are recognised as being among the most highly paid factory workers in the motor-car industry. The firm is not affiliated to the Engineering and Allied Employers' National Federation and, when rejecting a recent wage demand from its workpeople, declared that adult men in its employ earned an average of 14*l*. 3*s*. for a week of 42½ hours.

It was announced on December 16 that the company's decision respecting the trade-union activities of shop stewards during working hours at its factories in Coventry would be investigated at a meeting of the Coventry district committee of the Confederation of Shipbuilding and Engineering Unions on December 22. It was also made known that the committee would discuss changes in the procedure relating to disputes involving the firm. The Standard Motor Company has suggested that a new clause should be placed in its agreement with the unions. This would provide that, failing the settlement of a dispute, and where it was not referred to arbitration, no stoppage of work either of a partial or general character, should take place until after the lapse of at least 14 days.

For the three months to mid-November last there was no change in the level of retail prices in the United Kingdom. It was announced by the Ministry of Labour and National Service recently that the figure of the interim index of retail prices stood at 140 for "all items" on November 17, 1953. This figure compared with one of 138 for mid-November, 1952. The index measures the level of retail prices compared with that obtaining on June 17, 1947, which is taken as 100.

Vacancies for men required in connection with extensions to its factory were announced on December 15 by the Winfray Engineering Company, Limited, Coventry. One of the conditions of their employment, the firm stated, would be that any men taken on would agree not to take part in any token strike, or refuse to do overtime or piecework. This company, it may be recalled, dismissed 67 of its employees who participated in the recent token strike, but re-engaged the men after coming to an understanding with the unions concerned.

CIRCULAR-KILN BRICK-MAKING PLANT.

Fig. 5.

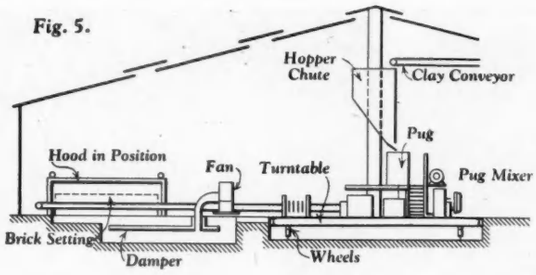
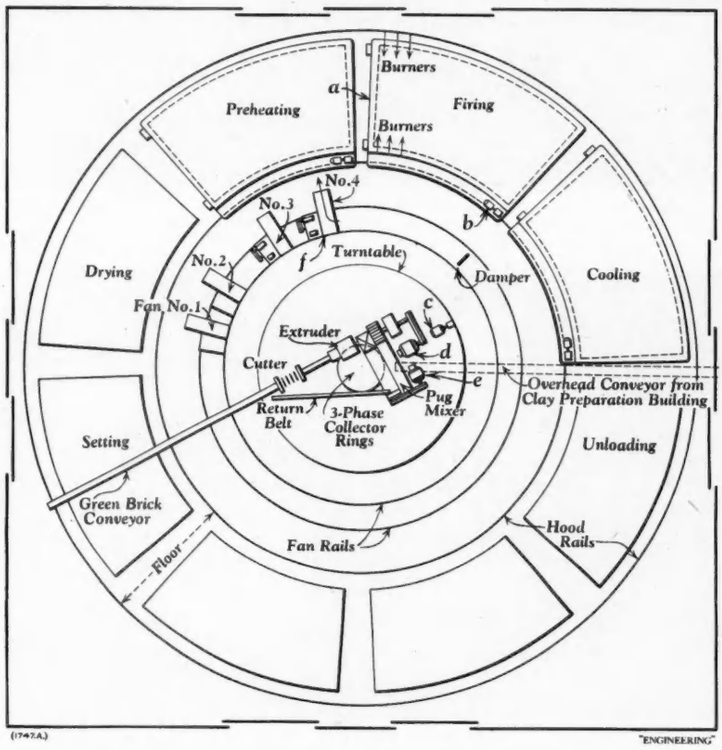


Fig. 6.



ELECTRICALLY-OPERATED CIRCULAR-KILN BRICK-MAKING PLANT.

A GOOD example of the application of mechanisation to the manufacture of bricks is to be found at the Moorebank works of Clark Kilns (N.S.W.) Pty., Limited, which are situated some 17 miles from Sydney. The site covers 100 acres, below which are deposits of clay and shale sufficient, it is estimated, for 100 years of continuous output. These materials are excavated by tractors and buckets and are stored under cover so that brick-making can be carried out during wet weather when the pit cannot be worked. They are taken from the store by a conveyor, which is driven by a 5-h.p. motor through gearing, and discharged into the hopper of an even feeder driven by the 20-h.p. squirrel-cage motor illustrated in Fig. 1, on page 816.

The clay and shale are then raised by a bucket elevator and passed through a bar disintegrator, the fast and slow rolls of which are driven by a 30-h.p. and 5-h.p. motor, respectively. They next go through two smooth-roll crushers with a combined capacity of 100 tons per hour, each of which is driven by two 20-h.p. motors. The drives of the bar disintegrator and smooth-roll crushers are shown in Fig. 2, on page 816. These crushers, in turn, discharge on to another conveyor, which delivers the load on to the central turntable of the kiln, the arrangement of which is shown in plan and half section in Figs. 5 and 6. All these motors are controlled by push buttons, which are arranged to start the plant in the correct sequence. There is a "stop-all" button for emergency use.

The kiln turntable is 50 ft. in diameter and is rotated by a 3-h.p. motor, which is shown at *c* in Fig. 6, through worm and chain gearing. This enables it to be turned so that the "green bricks" conveyor can be moved in accordance with stacking requirements without stopping production. The turntable carries a pug mixer into which the clay is passed from the hopper down a regulated chute and where water is added. This mixer is driven by a 150-h.p. slip-ring motor, which is indicated at *e* in Fig. 6, and is illustrated in Fig. 3, on page 816. From the mixer, the clay is fed into an extruder, which is driven by a 200-h.p. slip-ring motor (*d* in Fig. 6) and then through a mechanically-operated cutter, which parts off 13 bricks per cut. To facilitate stacking on the kiln floor the gap between adjacent bricks is opened out by a roller and off-cuts and rejects are placed on a belt, which returns them to the pug mixer for re-processing. All the machinery on the turntable is controlled from a push-button console between the extruder and cutter. As in the case of the preparation plant, a "stop-all" button is provided for emergency.

The "green" bricks are taken by a conveyor to the stationary kiln floor, where they are set. This floor, the external diameter of which is 160 ft. and the internal diameter 97 ft., is divided into eight segments each of which is capable of carrying 65,000 9-in. by 4$\frac{5}{16}$-in. by 3-in. bricks. Normally, six segments are in use at a time, one of which is being loaded with bricks from the turntable, while four carry charges which are, respectively, undergoing drying, pre-heating, firing and cooling. The finished bricks are simultaneously being unloaded from the sixth segment, all these operations being effected without moving the bricks.

The pre-heating, firing and cooling processes necessary for manufacture are carried out by three movable hoods, which can be traversed over the eight segments of the kiln floor on circular rail tracks. This operation is carried out by two 3-h.p. motors, illustrated in Fig. 4, on page 816, and the position of which is shown at *b*, in Fig. 6. Each of these hoods is fitted with a vertical lift door, as shown at *a*, in Fig. 6, which is used to separate the bricks in adjacent segments. The firing hood is fitted with gas burners, which are supplied from a 10-ft. agitator-type Wellman Galusha producer with an output of 300,000 cub. ft. per hour of gas of a calorific value of 130 B.Th.U. per cubic foot. This producer is fully automatic in action; the supply to the hood is controlled by water seals instead of by valves. The products of combustion are drawn off downwards and then passed upwards through the bricks under the pre-heating hood before being discharged to the atmosphere. The temperature of the bricks under the cooling hood is controlled by drawing cool air down through the bricks. It is then discharged through the bricks in the drying segments.

The air and products of combustion are circulated through the hoods and drying segment by four fans, which are mounted on circular rail tracks in the space between the turntable and the hoods, as shown at *f*, in Fig. 6. These fans, which can operate at temperatures up to 1,600 deg. F, are each driven by a 50-h.p. squirrel-cage motor and can be moved to the appropriate segment by hand. They are connected to the segment by a circular flue in the floor underneath the rail tracks. This flue is divided by dampers into two arcs, one of which connects the firing hood to the pre-heating hood, while the other provides paths from the cooling hood to the drying segment. The fans are grouped in pairs at the delivery ends of the flues adjacent to the drying and pre-heating segments of the kiln. The static pressure in the flues is therefore always less than that of the atmosphere, so that any leaks in the system result in an inflow of cold air; and the escape of hot air, which would be detrimental to operation, is prevented.

Returning to the electrical arrangements, there are, in all, 50 motors with individual outputs ranging from $\frac{1}{2}$ h.p. to 200 h.p., the total capacity being 850 h.p. All these motors were manufactured at the Witton works of the General Electric Company, Limited, and were supplied by British General Electric Pty., Limited. Most of the control gear was also manufactured in this country.

AIRCRAFT ENGINEERING APPRENTICES.—A. V. Roe and Co., Ltd., Greengate, Middleton, Manchester, have announced that some thousands of applications were received for 130 apprenticeships available next year. The 130 successful candidates were selected from a "short list" of 1,500 young men.

INTERNATIONAL RURAL ELECTRIFICATION.—A meeting of the United Nations Economic Commission for Europe, which was held in Geneva at the end of November, was concerned with an interchange of ideas on rural electrification in Europe as well as in Latin America, Asia and the Far East. A lengthy working paper on the technical, economic, administrative and financial sides of the problem was considered. It is being used as the basis of a programme for international collaboration in this field, which will be of assistance to the less industrialised countries.

SHIPBOARD TRIALS OF BRISTOL 173 HELICOPTER.—The prototype Bristol 173 Mark I twin-engine tandem-rotor helicopter designed and constructed by the Bristol Aeroplane Co., Ltd., Filton, Bristol, recently carried out successful trials at sea on board the aircraft carrier H.M.S. Eagle. The trials were undertaken to determine the behaviour of the machine in varying conditions of deck motion; to carry out tests of rotor-blade behaviour, particularly during starting and stopping; and to investigate the manœuvrability of the machine on the flight deck and to examine stowage problems. The trials included several successful take-offs and landings.

MECHANICAL FORESTRY EQUIPMENT.

FORESTRY equipment has been largely regarded as an American and Canadian monopoly owing to the extensive timber resources, and consequently large timber trade, of those countries, but a recent demonstration, which was the last of a series staged in different parts of the country during the past year, showed that British manufacturers are now well able to challenge that monopoly.

The recent demonstration of British-built forestry equipment was given at the end of November, in Dorset, on the estate of Lord Digby, and was organised by David Brown Tractors (Engineering), Limited (part of the David Brown Corporation, Limited, Meltham, Yorkshire), and T. T. Boughton and Sons, Limited, Amersham Common, Buckinghamshire. Among the items of equipment demonstrated were a David Brown 50 ITD crawler fitted with a Boughton-HD4 power-driven winch and a hydraulic angledozer made by Blaw-Knox, Limited, 90-94, Brompton-road, London, S.W.3; a David Brown 30 ITD crawler fitted with a Boughton HD2 power-driven winch, one of which was illustrated on page 784, *ante*, and a Blaw-Knox bulldozer; and an American-type logging-arch, skid-pans and chokers, in the manufacture of which accessories the timber-extracting firm of T. T. Boughton and Sons, Limited, also specialise.

The David Brown crawlers demonstrated were specially equipped for forestry work, having substantial radiator and crankcase guards as standard equipment. The 50 ITD model has a six-cylinder Diesel engine with a bore and stroke, respectively, of 3⅜ in. and 4 in., which give a piston displacement of 248 cub. in. The engine speed is governed to a maximum of 1,800 r.p.m., the rated speed being 1,600 r.p.m., at which the drawbar horse power is 32, corresponding to a pull of 8,000 lb. in low gear. The 30 ITD model has a four-cylinder engine of identical bore and stroke and giving a drawbar horse power of 21·7 at 1,600 r.p.m., corresponding to a pull of 7,500 lb. in low gear. Both models have Borg and Beck single dry-plate clutches and have a three-speed and single-reverse gearbox, together with a dual-ratio drive, providing, in effect, six forward and two reverse speeds; both models are also fitted with a four-speed power take-off as standard equipment, so giving four winding speeds. The logging arch was demonstrated in the manner illustrated at Fig. 1; this illustration shows the method of loading a pole-wagon by backing the arch up to it and then lowering the suspended log on to it by means of the Boughton winch.

The arch was also demonstrated for raising the butt-end of a log sufficiently clear of the ground to enable it to be hauled, the other end of the log dragging along the ground. A variation in log-hauling is the use of a skid-pan, such as that illustrated at Fig. 2, which shows a log being hauled with its butt end resting on a skid-pan to which it is anchored by a chain fitted with a quick-releasing device. An interesting demonstration showed the ease and speed with which the two crawlers, placed a few feet apart, could roll a log about 3 tons in weight from ground level on to a partly-loaded pole-wagon, by means of their winches, the steel ropes of which were passed over the load on the wagon, under and round the log, and then again over the wagon, to be hooked on to the back of the crawlers. Other demonstrations showed the ability of these machines to clear undergrowth and to take out roots, and it was at all times evident that they had ample power to cope with the duties to which they were put.

LAUNCHES AND TRIAL TRIPS.

M.S. "TANTALLON CASTLE."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Belfast, for the Union-Castle Mail Steamship Co., Ltd., London, E.C.3. Main dimensions: 465 ft. between perpendiculars by 65 ft. 6 in. by 41 ft. 6 in. to shelter deck; gross tonnage, 7,450. Eight-cylinder double-acting two-stroke oil engine. Launch, October 22

S.S. "PATHFINDER."—Twin-screw survey vessel, built by J. Samuel White & Co., Ltd., Cowes, Isle of Wight, to the order of the Crown Agents for the Colonies, Millbank, London, S.W.1, for the Government of Nigeria. Main dimensions: 162 ft. overall by 27 ft. 6 in. by 12 ft.; deadweight capacity, about 340 tons on a draught of 10 ft. Two triple-expansion reciprocating steam engines, together developing 700 i.h.p. at 150 r.p.m. and one oil-burning cylindrical boiler, constructed by Plenty and Sons, Ltd., Newbury. Speed, 11½ knots. Launch, October 23.

M.S. "JARANDA."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, for Anders Jahre & Co., Sandefjord, Norway. Main dimensions 573 ft. 6 in. overall by 73 ft. by 39 ft. 3 in. to upper deck; deadweight capacity, about 18,500 tons. Harland-B. and W. six-cylinder two-stroke single-acting opposed-piston oil engine. Launch, October 23.

M.S. "JUSTUS WALLER."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, for the Rederi A/B Castella, Gothenburg, Sweden. Main dimensions: 550 ft. overall by 66 ft. by 39 ft. 3 in.; deadweight capacity, 17,500 tons on a draught of 30 ft. 2½ in. Götaverken nine-cylinder single-acting two-stroke Diesel engine, developing 6,750 b.h.p. at 112 r.p.m. Service speed, about 15 knots. Launch, October 27.

M.S. "TUNGUFOSS."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Burmeister and Wain, Ltd., Copenhagen, Denmark, for H/f. Eimskipafjelag Islands, Reykjavik, Iceland. Main dimensions: 240 ft. between perpendiculars by 38 ft. by 22 ft. 6 in. to main deck; deadweight capacity, 1,700 tons on a summer draught of 15 ft. 1½ in.; cargo capacity, 105,000 cub. ft. Seven-cylinder single-acting two-stroke Diesel engine, developing 1,800 i.h.p. at 300 r.p.m. Speed on trial, 12½ knots. Delivered, October 29.

S.S. "PACIFIC NORTHWEST."—Single-screw cargo vessel, with accommodation for twelve passengers, built by Vickers-Armstrongs Ltd., Walker-on-Tyne, for Furness, Withy & Co., Ltd., London, E.C.3. Main dimensions: 497 ft. by 63 ft. 2 in. by 41 ft.; deadweight capacity, about 10,500 tons on a draught of 28 ft. 6 in., refrigerated-cargo capacity, 130,000 cub. ft. Geared steam turbines, developing 7,700 s.h.p., constructed by Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne. Service speed, 15½ knots. Launch, November 5.

M.S. "BORDER KEEP."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Lowland Tanker Co., Ltd. (Managers: Common Brothers, Ltd.), Newcastle-upon-Tyne. Main dimensions: 515 ft. between perpendiculars by 69 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, 16,150 tons. Rowan-Doxford six-cylinder opposed-piston two-stroke oil engine, developing 6,800 b.h.p., constructed by David Rowan & Co., Ltd., Glasgow. Speed on trial, 15½ knots, fully loaded. Trial trip, November 19.

M.S. "EUMAEUS."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Blue Funnel Line of Alfred Holt & Co., Liverpool. Main dimensions: 487 ft. overall by 62 ft. by 35 ft. 3 in. to upper deck; gross tonnage, 7,870; deadweight capacity, about 9,220 tons. Seven-cylinder single-acting two-stroke Diesel engine, developing 7,600 b.h.p., constructed by Harland and Wolff, Ltd., Belfast. Service speed, 16 knots. Trial trip, November 28.

MECHANICAL EQUIPMENT FOR FORESTRY.

FIG. 1. LOADING POLE-WAGON BY LOGGING ARCH.

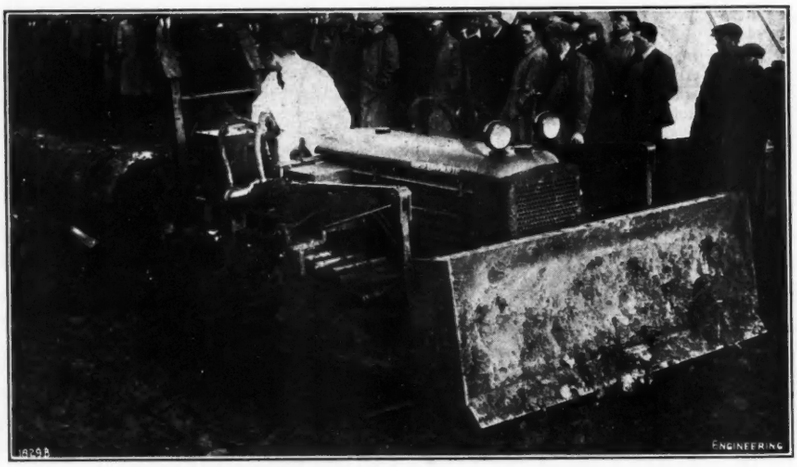
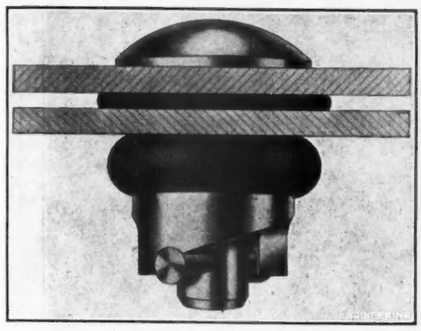


FIG. 2 HAULING TREE TRUNK ON SKID PAN.

PANEL FASTENERS.

A NEW type of panel fastener for metal, glass or plastic, designed for simple installation without special tools or countersunk holes, and for speed in operation, has been developed by Silentbloc Limited, Victoria-gardens, London, W.11. The Vibrex fastener, which is assembled as a complete unit in the removable panel, consists of a stud, a rubber sleeve, a cam, and a retaining pin. The stud is inserted through a $\frac{7}{16}$-in. diameter hole in the removable panel, and the rubber sleeve



and cam are assembled on it. In the example illustrated, a rubber cushion washer, to eliminate metal-to-metal contact between the panel and the base plate, is placed on the stud before fitting the rubber sleeve. The retaining pin is then inserted by pressing the cam down on its edge and passing the pin through the hole in the stud, the latter being lined up with the deepest recesses in the cam.

After assembly of all the fasteners in the removable panel, the latter is attached to the base plate by inserting the fasteners in plain $\frac{1}{2}$-in. diameter holes drilled in the base plate. Each fastener is then locked by turning the head of the stud with a screwdriver, or a coin, so that the cam rides up the retaining pin until the latter engages in a detent on the lower part of the cam face. The expansion of the rubber sleeve in the $\frac{1}{2}$-in hole in the base plate locks the fastener and provides an anti-vibration panel mounting.

BODY-WORK FOR COMMERCIAL VEHICLES.—On Friday, December 11, the Rt. Hon. A. Lennox-Boyd, Minister of Transport, opened a new factory for Bonallack and Sons, Ltd., on the Basildon Trading Estate, Essex. The company, who have been established more than 120 years, are makers of body-work for all types of commercial vehicles, now specialising in the use of light alloys. The new factory is expected to enable the company to double its output of special-purpose vehicles. Particular attention has been paid to the layout of the paint shop and spray booths, all of which are equipped with air-conditioning and heating apparatus designed to provide optimum conditions for the application of finishes.

SHIPBUILDERS AND STEEL SUPPLIES.—Reference to the steel position was made at three recent ship launches on the River Wear. At the launch of the 10,200-ton Pindar, a cargo motorship built by Short Brothers for Panama owners, Mr. John Short, director of the builders, said that the construction of the ship had been delayed by the shortage of steel. Nine months ago, his firm were receiving practically no steel, but there had been an improvement, both in quantity and in the rate of delivery. Mr. Short said that his firm had booked no new orders for 18 months, though they still had a good amount of work in hand. Speaking at the launch of the 16,000 ton tanker Border Lass, built by William Doxford & Sons for the Lowland Tanker Co., Mr. J. Ramsay Gebbie, managing director of Messrs. Doxford's, said that though the steel position had improved, it was not nearly as good as he would like. The Border Lass is the 800th ship built by William Doxford & Sons, and the third of ten ordered from various firms by the Lowland Tanker Co. At the launch, by Bartram & Sons, of the 12,000-ton motorship Thorpe Grange, for the Houlder Line, Mr. R. A. Bartram said that the building of the ship had been delayed entirely through the shortage of steel. The prospects for the immediate future, he added, were very little better. He was surprised that shipowners had not been more vociferous about the steel shortage, in view of the delays and annoyance it must have caused them.

DEVELOPMENTS AND POSSIBILITIES IN ELECTRICITY GENERATION.

SIR JOHN HACKING delivered his presidential address to the Junior Institution of Engineers on Friday, December 11, taking as his subject "Developments and Future Possibilities in Electricity Generation." Both the electricity supply industry and the Institution were, he said, founded about 70 years ago. Both had done credit to the early pioneers.

In 1920 the number of electricity consumers had reached one million and the annual consumption was a little over 3,500 million kilowatt-hours. In the year ended March 31, 1953, the number of consumers had risen to nearly 14 millions, while the consumption was over 52,000 million kilowatt-hours. To meet the growth of load, it was necessary to plan the construction of new generating plant well ahead. During the war, however, only the minimum amount could be built. The post-war recovery period had been prolonged by shortages of material and labour, and it was only in the last two years that the installation of new plant had exceeded the rate of growth. Even so, there would be a deficit of some 1,500 MW this winter if the weather was exceptionally severe. The British Electricity Authority therefore wished to bring new plant into commission at the rate of 2,000 MW a year as soon as possible. They were limited to 1,750 MW in 1958 by the Government capital investment programme, but it was hoped that this would be increased to 1,950 MW in 1959.

TRANSMISSION ECONOMICS.

The 132-kV grid had been constructed to provide interconnection capacity within a number of self-contained regions. Since shortly before the war, however, it had been operated as a single national interconnected system, and undoubtedly had achieved great economies, both in plant and running costs. It was primarily to provide adequate interconnection capacity that the 275-kV grid was being constructed, since it had been estimated that the capital cost of transmitting power in bulk at high load factor from stations in the Midlands and Yorkshire coalfields to areas where coal was deficient would be less than that of the local generating plant necessary to obtain the same security of supply. It was also found that by increasing the conductor size to give a thermal rating of 570 MVA per circuit considerable overall savings could be made on account of reduced coal transport charges. The towers for these wires were being constructed with extra clearances so as to permit 380 kV to be used, thus giving a rating of 800 MVA per circuit, should this prove practicable and economic.

The expansion of the East and West Midlands and Yorkshire coalfields was a factor of major importance in the planning of the supergrid and the siting of new generating plant. Accordingly, it had been decided to build a number of large base loads stations in these areas to provide by 1960 a total export of 1,000 MW at peak periods and up to 2,500 MW during off-peak periods. Base-load stations to supply local loads from local coal were also to be built in South Wales, on the North-East Coast and at Kincardine. In future, other base-load stations would be constructed on the Thames Estuary, but rapid development of these did not appear advantageous, as, with the bulk of the fuel coming from inland coalfields, it would be generally more economic to transmit the base-load electrically, as long as suitable sites for generating stations could be found. Supplies of cooling water presented a major difficulty as river sites became used up; and the tendency would be to develop coastal and estuary sites, where, however, the abundance of the cooling water would be set off by higher coal-transport costs.

GENERATING PLANT DESIGN.

Turning to the main features of the new generating plant, Sir John said that, of the 10,000 MW under construction or planned up to 1958, 6,000 MW would employ steam at 900 lb. per square inch and 900 deg. F., while 2,000 MW would operate under higher conditions. A number of 100-MW sets, which would run at 1,500 lb. per square inch and 1,050 deg. F. and have a thermal efficiency of 32·8 per cent., were on order. It was thought at one time that these might become standard, but since then a number of 120-MW sets employing the reheat cycle with steam at 1,500 lb. per square inch and an initial temperature of 1,000 deg. F., and reheating to 1,000 deg. F., had been included in the 1957 and 1958 programmes. These sets would have a thermal efficiency of 34·7 per cent. Over the past 12 months the average thermal efficiency for British Electricity Authority steam stations had been about 23 per cent. It was, however, expected that 26 per cent. would be reached in 1960 and 30 per cent. might well be obtained within the following ten years.

Apart from the increasing size of plants, there were three outstanding features in present developments: the increasing use of pulverised-fuel firing, the adoption of the unit system for generators and boilers, and the re-introduction of the reheat cycle. The use of cyclone burners, in which crushed instead of pulverised fuel was used and combustion took place in a separate chamber from which the products were discharged into the furnace, might also be mentioned. The introduction of hydrogen-cooling of alternators was another important development. To gain experience with semi-outdoor stations, a station of this type was being built at Ince, in Cheshire, and another would be constructed at Willington, on the River Trent.

FUTURE STEAM CYCLES.

As regards future steam cycles, experience indicated that the safe limiting pressure for a drum-type boiler was about 2,700 lb. per square inch. A plant was being designed to work at this pressure, giving a pressure of about 2,350 lb. per square inch at the turbine stop valve. It should be in commission in 1959. With initial temperatures of about 1,100 deg. F. and reheating at about 550 lb. per square inch to 1,050 deg. F., it was estimated that the optimum station "sent-out" efficiency would be about 37·6 per cent., when using British coals of high ash-content. The economic size of the generators would be from 180 to 200 MW and they could be built as either tandem-compound or cross-compound units, running at 3,000 r.p.m. It would be necessary to use a combination of hydrogen cooling and oil-cooled stator bars on the single alternator (180 to 200 MW) of a tandem-compound unit, but hydrogen-cooling only would suffice for the pair of 90 to 100-MW alternators of the cross-compound unit. A 120-MW plant was to be built in America for steam conditions of 4,500 lb. per square inch and 1,150 deg. F. with double reheating, first at 1,200 lb. per square inch to 1,050 deg. F. and then at 180 lb. per square inch to 1,000 deg. F. A unit boiler of the "once-through" forced-circulation type would be used. In these super-critical cycles more than four-fifths of the heat was absorbed in superheating and reheating, leaving less than one fifth to be absorbed in the evaporating section. The American unit would be cyclone-fired, the cooling coil of the cyclone providing most of the heat required for evaporation. An optimum station "sent-out" efficiency of over 40 per cent. was expected. It was estimated that, with an initial pressure of 6,000 lb. per square inch and a temperature of about 1,200 deg. F. for superheat and reheats, the efficiency might be about 42·5 per cent.

GAS TURBINE DEVELOPMENTS.

Gas turbines also offered prospects of high thermal efficiency, though they were unlikely to prove economic in this country for power generation unless they could be developed for coal-burning. It might be possible to obtain thermal efficiencies of over 40 per cent. Most of the successful gas turbines were operating on the open cycle, and the British Electricity Authority were installing two plants of that type. The North of Scotland Hydro-Electric Board were installing an experimental closed-cycle gas turbine at Dundee. A further possible application was to use the exhaust from an open-cycle gas turbine in a steam boiler. This exhaust could be used for combustion, as it would consist mainly of air. The combustion air would be at 800 deg. F.,

or more, so that no air heater would be needed; there would only be an oversize economiser. Another scheme was to use air not only for combustion, but for feed heating and reheating. A development which was being considered by Electricité de France was to use free-piston Diesel-driven compressors to provide the combustion air, which was preheated by the Diesel exhaust gases. The hot gases from the boiler and the cooled Diesel exhaust gases were passed to the gas turbine. The jacket losses of the compressors were used for feed heating. It was claimed that an overall efficiency of over 42 per cent. could be achieved by these means. Other possibilities were the substitution of a waste-heat boiler for the gas-to-air heat exchanger in an open-cycle gas turbine; and the use of steam as the working fluid in a gas turbine, part being further expanded through a condensing turbine. Alternatively, the condensing turbine might be omitted, and steam be passed out for process purposes.

Combined Electricity and Heat Generation.

Dealing with the combined generation of electricity and heat, Sir John said that such schemes were attractive if the necessary markets could be found; but the capital costs of the plant were not necessarily less than those required for generating like quantities of heat and electricity separately, and for district heating the cost of the distribution system might be so high as to render the project uneconomic. The fuel economy of combined plants depended on generating steam at as high a pressure and temperature as practicable and expanding it through the turbine to the desired process pressure. The higher the initial pressure, the greater the amount of electricity generated and the greater the overall fuel economy. Where heat-using industries could be located close to a large base-load power station, their requirements could be met more economically by bleeding the turbines in the power station than by installing back-pressure or pass-out plant in the factories. If a group of large factories were located near a large power station and their aggregate process-steam requirements were, say, 500,000 lb. per hour, they could be supplied by two or three specially-designed sets. These would have smaller low-pressure turbines and condensing plants, but would receive the same quantity of steam as the remaining standard sets.

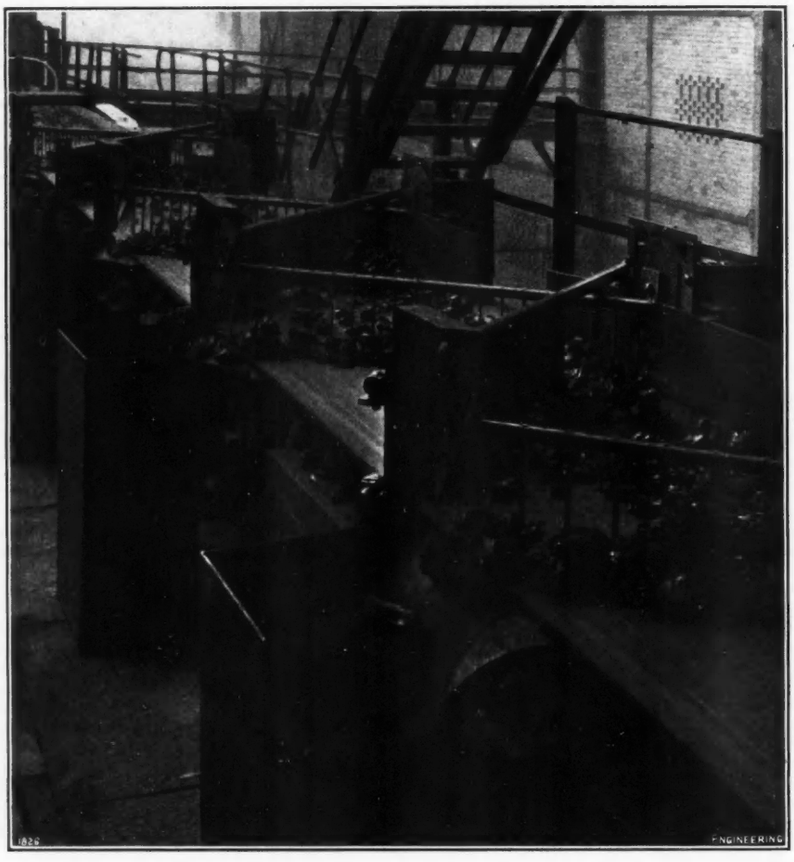
Alternative Fuels.

The conversion of chemical energy to electrical energy without an intermediate thermodynamic stage had long been regarded as attractive, owing to its high efficiency, but none of the investigations in progress had gone beyond an exploratory stage. Generation of electricity from wind and tidal power had also been considered, but these, together with further hydro-electric power projects, could not be expected to make an energy contribution equivalent to more than 5 million tons of coal in 20 years time. By then, the additional coal needed for electricity generation might be five or six times that amount. The source of energy which was most likely to supplement and, in time, replace coal was nuclear energy, as the heat from the thermal reactors could undoubtedly be used for generating electricity, employing relatively conventional heat exchangers and turbines. Until more experience had been obtained, it was impossible to make reliable comparisons with coal-fired plant, although it was not unlikely that there would be a considerable extension of that type of installation within the next three of four years.

The development of nuclear energy for electricity generation would probably take place in two stages. In the first, natural or slightly enriched uranium would be used in thermal reactors, which would burn U235 and produce a certain amount of plutonium. In the second stage, which could not be begun until breeder reactors were available, either greatly enriched uranium or plutonium would be employed. The way appeared to be fairly clear for the first stage, but the second depended on further development. There seemed no reason to doubt that a contribution of 2,000 to 3,000 MW, employing thermal reactors, would be available within 15 to 20 years, by which time, too, the application of breeder reactors should be well advanced.

CONVEYOR TYPE OF SEPARATOR.

WEST'S GAS IMPROVEMENT CO., LTD. MANCHESTER.



CONVEYOR SEPARATOR.

The display by West's Gas Improvement Company, Limited, Albion Ironworks, Miles Platting, Manchester, 10, at the Fuel Efficiency Exhibition held in the City Hall, Deansgate, Manchester, last month, included a working model of their selective-screen conveyor. The conveyor, which is illustrated above, has only recently been put on the market. It is claimed to combine distribution with a screening by progressive elimination, without causing vibration in the supporting structure. The material to be graded is carried on a non-vibrating surface throughout the screening process. So far, the selective-screen conveyor has been applied mainly to the grading of coke, but it is expected to have many applications in the handling and grading of other materials.

It consists of a normal flat-band conveyor with the addition of comb-like screens, which can be seen in the illustration, mounted above the band at an angle across the line of travel. Clogging of the screens is prevented by vibrators of low power-rating, which oscillate them rapidly, with a low amplitude, over their full length. The ends of the screens are supported on flexible rubber and steel mountings. The conveyor grades in descending order of size, so that little damage is normally done to the material, in contrast with separators in which the largest size passes through a number of oscillating devices before being finally sorted. The capacity of the machine depends upon the width of the conveyor belt. The conveyor and its allied components are constructed on the unit principle so that its length can be easily changed to suit any handling scheme. The screening elements are also made in various gauges to suit particular requirements.

Among the advantages claimed for the selective-screen conveyor are a high efficiency, even when considerably overloaded; screening of coke and breeze or similar materials of high moisture content without blockage of screening elements; minimum breakage of material during screening; and freedom from vibration of the supporting structure and hoppers.

New Low-Power Broadcasting Station.—A new low-power broadcast transmitting station was opened at Mousewald, near Dumfries, on Sunday, December 13, to improve the reception in Lochmaben, Lockerbie and Annan. It has a power of 2 kW and will radiate on 371 m. (809 kilocycles) from 4 p.m. in the evenings only.

Christmas Lectures of the Institution of Civil Engineers.—Three lectures intended for boys between the ages of 13 and 17 have been arranged by the Institution of Civil Engineers, and will be delivered at the Institution building, Great George-street, London, S.W.1, on Tuesday, Wednesday and Thursday, December 29, 30 and 31, commencing at 3 p.m. The lectures will be, respectively, "Marine Salvage Operations," by Commodore T. McKenzie; "Diving in the Royal Navy," by Lieut.-Commander G. H. Lawther; and "The Harnessing of Water in Power Development," by Mr. T. A. L. Paton. Tickets may be obtained gratis from the Institution at the above address.

Protection of Motors with High Inertia Loads.—A trip relay, which will carry a heavy starting current over the relatively long time required to accelerate a motor carrying a high inertia load without risk of premature tripping or prejudicing the normal overload protection, has been developed by the General Electric Co., Ltd., Kingsway, London, W.C.2. It consists essentially of a trip coil, a screwed adaptor sleeve, an oil dash-pot and an operating plunger. On top of the plunger is an iron thimble, which becomes saturated when the current exceeds a given value. Increased current therefore no longer strengthens the magnetic pull, so that tripping is delayed. Independent setting of the operating time and overload setting are provided.

VARIABLE-SPEED GEAR AND PULLEY DRIVES.

BOURDON TOOLS LIMITED, Union-road, Croydon, Surrey, have been appointed agents for the variable-speed gear and pulley unit, which is shown in Fig. 1, mounted together with an electric motor on a simple baseplate. The makers of this variable drive, known as the Omnia gearbox, are Buhrs and Zonen, N.V., Zaandam, Holland. Two sizes of the drive are available, one for transmitting 1 h.p. and the other for 3 h.p. Each size is made in three types which, for a constant input speed of 1,000 r.p.m., give output speeds of 578 to 1,730 r.p.m., 197 to 1,730 r.p.m., and 64 to 1,765 r.p.m.

The larger gearboxes are laid out as shown in

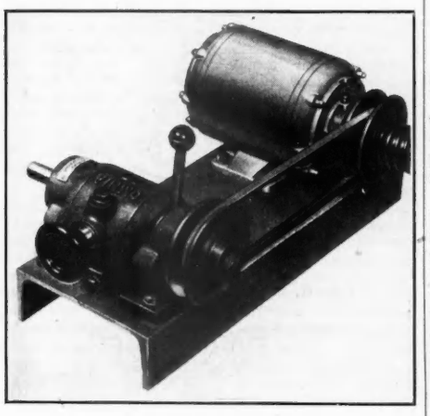


FIG. 1.

Fig. 2.

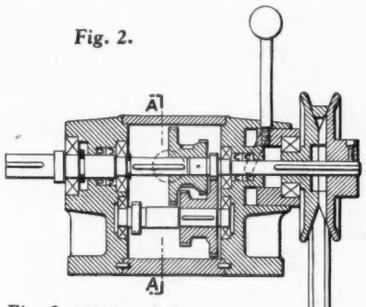
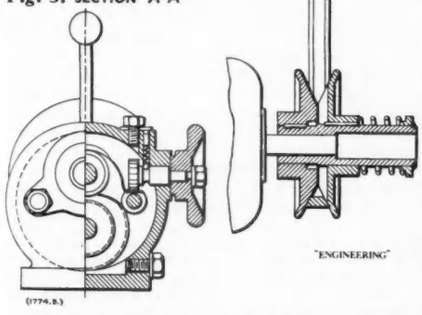


Fig. 3. SECTION A-A



Figs. 2 and 3. A self-expanding type of pulley, made in two halves and spring loaded, is mounted on the main shaft of the motor and a pulley, having an adjustable effective diameter, is mounted on the main housing. The effective diameter at which the V-belt runs depends upon the belt tension and this is adjusted by the hand lever shown protruding from one end of the variable-drive unit. This lever can be moved along a helical slot to vary the distance between the inner faces of the driven pulley, thus changing the diameter around which the belt runs and the motor pulley automatically adjusts itself to suit. This gives an increase or reduction in the output speeds and is the arrangement used for the first of the three types mentioned above, with smallest speed range. In the case of the second and third types, a gearbox is also incorporated as shown in Figs. 2 and 3; these have two and three gear selections respectively to give the increased speed range. Sliding gears are used and they are selected by the handwheel shown in Fig. 1 at the front of the casing, which operates a small rack-and-pinion control for moving the gears. The output speeds from the gears overlap the initial speed in the next gear.

The gears and shafts are made from a high-tensile steel and hardened and ground. S.K.F. bearings are fitted at each end of the shafts together with oil seals; the gearbox has been designed for splash lubrication and requires to be kept filled with oil to one third of its depth. The rack and pinion fitted are both made from bronze.

ALUMINIUM-ALLOY LIFEBOATS.

A RANGE of aluminium-alloy lifeboats is being manufactured by Norsk Flyindustri A/S, Oslo, Norway, from Birmabright B.B. 3 aluminium-alloy extrusions and sheet, and recently one of the 46-seater models, equipped with sails, radio and powered by a Petters marine Diesel engine, made a successful crossing of the North Sea from Oslo.

These lifeboats comply with the requirements both of the Ministry of Transport and the Norwegian, Swedish and Danish Boards of Trade; they are manufactured in ten different sizes ranging from 18 ft. 8 in. to 30 ft. 9 in. in length, with beam-widths from 6 ft. 3 in. to 10 ft. 4 in., and are designed to carry from 19 to 85 persons. In all cases, riveted construction is used for the hull, buoyancy being provided by a number of tanks which are arranged along the sides of each vessel and also serve as seating accommodation. These buoyancy tanks are of welded construction and are riveted into position; each is fitted with a quickly detachable cast aluminium-alloy cover, 9 in. in diameter, which renders the interior of the tanks fully accessible, and permits them to be used to afford air and watertight protection to fragile equipment and food supplies. Also fitted to each boat is a semi-rotary hand-pump for removing bilge water and for fire-fighting.

The model which recently crossed the North Sea has a length of 26 ft. 7 in. and a beam of 8 ft. 3 in., and the engine installed is the 10-h.p. vertical twin-cylinder marine Diesel, type AV2M, manufactured by Petters, Limited, Staines, Middlesex. This engine has a bore and stroke of 3·15 in. and 4·33 in., respectively, and runs at 1,500 r.p.m. at full load; complete with the engine and equipment, the vessel weighed 2½ tons, or about half the weight of a comparable boat of timber construction. This saving in weight leads to lighter davits and, therefore, an overall reduction in the weight of top-hamper; another advantage claimed for lifeboats of this construction is that, whereas rough handling may cause a timber-built boat to split, all that can happen to aluminium-alloy lifeboats is that they may bend or become dented, which does not materially affect their seaworthiness.

GUIDED WEAPONS: NEW MINISTRY OF SUPPLY APPOINTMENTS.—Owing to the general progress made in the field of guided weapons and the widening range of activities which such progress entails, the Minister of Supply (Mr. Duncan Sandys) has replaced the existing post of principal director of guided weapons by the establishment, under the controller of guided weapons and electronics, of a principal director of scientific research (guided weapons and electronics) and a director-general of guided weapons. The principal director of scientific research will be responsible to the controller for the general oversight of research and technical assessment in the field of guided weapons and electronics, and, on research matters, to the chief scientist. The director-general will be responsible for the general co-ordination of the current guided weapons research and development programme. The Minister has appointed Dr. R. Cockburn, C.B., O.B.E., at present scientific adviser to the Air Ministry, to be the principal director of scientific research (guided weapons and electronics) and Mr. J. E. Serby, C.B.E., at present deputy director of the Royal Aircraft Establishment, Farnborough, to be director-general of guided weapons, Mr. M. B. Morgan, the present head of the guided weapons department of the Royal Aircraft Establishment, succeeds Mr. Serby as Deputy Director of the Establishment.

BRITISH STANDARD SPECIFICATIONS.

THE following publications of engineering interest have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2, Park-street, London, W.1, at the price quoted at the end of each paragraph.

Electroplated Coatings of Nickel and Chromium.—A revision of B.S. No. 1224, dealing with electroplated coatings of nickel and chromium, has now been published. The specification was first issued in 1945 and it has been revised because the original did not meet fully the requirements of the motor-car industry. A thicker coating of nickel on steel has been provided and coatings on zinc alloys have been included. It has not been found possible to specify average thicknesses as these vary considerably with the size and shape of the article and the method of plating. It is also pointed out in the specification that the importance of conserving nickel has been taken into account in its preparation by specifying alternative coatings using copper under-coatings, and particular attention is drawn to these coatings. [Price 2*s.* 6*d.*, postage included.]

Nickel Anodes and Nickel Salts for Electroplating.—Another revision is entitled "Nickel Anodes and Nickel Salts for Electroplating." Originally issued separately in 1934, B.S. Nos. 558 and 564 are now published under one and the same cover. In this way the two specifications have been combined and brought into line with current practice. Clauses relating to nickel chloride have been added to B.S. No. 564. Details of the composition of anodes and salts together with limits of impurities are given in the new publication and methods of chemical analysis are included. [Price 4*s.*, postage included.]

Preferred Numbers.—The series of standardised numbers, known internationaly as "Preferred numbers," are finding increasing application in the preparation of standards, and in the devising of ranges of products and processes. The technical features, advantages and practical applications of these numbers are discussed fully in B.S. publication No. 1638 : 1950, entitled, "Report on the Selection of Ranges and Types and Sizes (Preferred Numbers)," by Mr. J. E. Sears, C.B.E. A new publication, B.S. No. 2045 : 1953, entitled "British Standard Preferred Numbers," has been prepared and issued with the objects of giving authoritative status to these numbers for application, where appropriate, in British practice, and moreover, of providing readily accessible information on the numbers themselves for those who may have occasion to use them. In the new publication are listed the preferred numbers in the four principal series R5, R10, R20 and R40, as well as the additional R80 series intended for special application. [Price 2*s.* 6*d.*, postage included.]

Paraffin Appliances.—As a result of the work carried out by a committee set up by the Ministry of Fuel and Power, the preparation of a specification for domestic appliances using kerosine (paraffin) as fuel has been authorised. The first portion (designated: Part 1) of the specification, B.S. No. 2049, has now been issued. This covers burners, portable space heaters, and cooking and boiler appliances, and the general constructional, guarding and safety requirements of these appliances are dealt with, and detailed performance tests laid down. Numerous line drawings of typical burners and appliances are given. [Price 10*s.*, postage included.]

Tubular Heat Exchangers.—A further specification in the series now being prepared for equipment used in the petroleum industry has been issued. It is B.S. No. 2041 and covers tubular heat exchangers. In view of the international character of the petroleum industry, careful consideration has been given to the standard publications of the Tubular Exchanger Manufacturers' Association of the United States for "R"-class heat exchangers. This will have the advantage of ensuring interchangeability in practice between equipment produced by American and British manufacturers. The new specification applies to shell and tube heat exchangers and covers dimensions and manufacturing requirements. It is divided into sections dealing with general requirements, materials, construction and workmanship, scantlings, testing and inspection and marking. The specification should be read in conjunction with B.S. No. 1500 (provisional) covering fusion-welded pressure vessels for use in the chemical and allied industries, or any other suitable code which may be specified. Appendices are included in the new publication giving details of the materials to be used, the dimensions of the shell, shell cover and channel flanges as well as pressure-temperature ratings for tube plates and flanges. A final appendix gives the information which, it is suggested, should be supplied by the purchaser or manufacturer as the case may be. [Price 12*s.* 6*d.*, postage included.]

RUBBER SUSPENSION OF RAILWAY BOGIES.

Fig. 1.

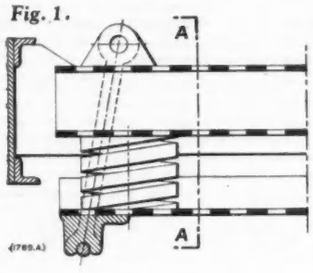


Fig. 2. SECTION A-A

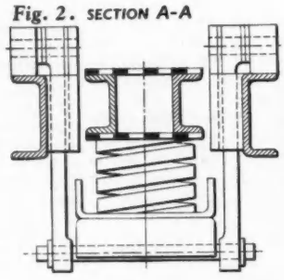


Fig. 3.

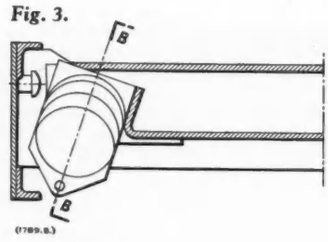


Fig. 4. SECTION B-B

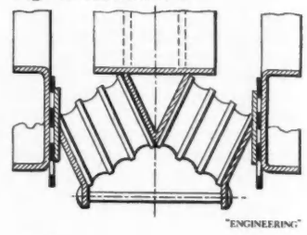


Fig. 5.

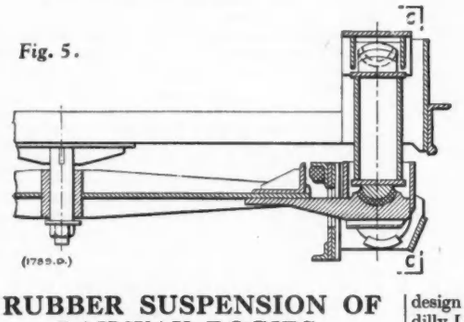


Fig. 6. SECTION C-C

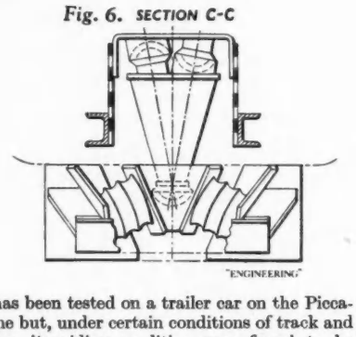


Fig. 7.

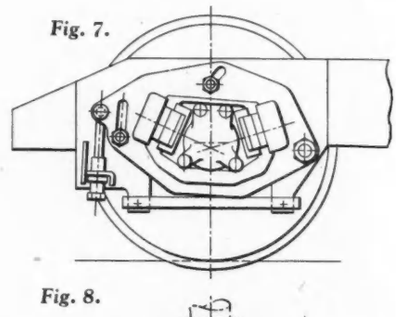
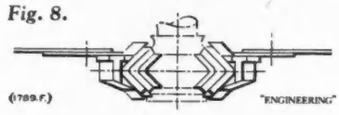


Fig. 8.



RUBBER SUSPENSION OF RAILWAY BOGIES.

EXPERIMENTS are now being carried out by the Development Division of the department of the Chief Mechanical Engineer (Railways) of London Transport, with various types of rubber suspension for the bogies of both tube and surface-line cars. The object of these experiments is to determine the practicability of suspending the whole bogie on rubber, and thus to reduce maintenance costs by eliminating all wearing parts such as rubbing plates, hanger pins and bushes, as well as the steel springs. This type of suspension would also, it is thought, go a long way towards reducing the running noises associated with the conventional bogie suspension, particularly in tunnels.

As is well known, the standard arrangement of bogie suspension consists of a spring plank hung by means of four hangers, two at each end, as shown in Figs. 1 and 2. The upper ends of the hangers are connected to the bogie side frame and the lower ends to the spring plank, which carries helical springs at each end for supporting the car body through the central pivot. To stabilise the car body for side oscillation, the hangers are inclined 8 deg. from the vertical. The experimental rubber-suspended bolster takes the form of two rubber packs at each end of the bolster, as shown in Figs. 3 and 4. By inclining the rubber packs inwards from the top towards the centre of the bogie, and outwards at the bottom longitudinally, it is possible to arrange for all loads, that is, the vertical load from the car body plus the passenger weight, the longitudinal loads due to traction and braking, and the transverse loads due to side oscillations, to be taken by the bolster. With this arrangement, rubber is used in shear as well as in compression. A District Line trailer car, fitted with this type of suspension, was placed in passenger service in October, 1947, and has run satisfactorily for the past six years.

An alternative design of bolster has been produced, in which the rubber packs are outside the bogie frame, the car body being mounted directly on the rubber through vertical struts, as shown in Figs. 5 and 6. This method of suspension eliminates the usual form of bogie centre-pivot bearing, as the weight of the car body is carried on the struts which, being inclined, provide a restoring force when they are moved out of centre by the swing on curves. When this type of bolster suspension is employed on a tube-stock bogie, it is not possible to provide the usual shoe-beam arrangement for carrying the collector gear. It is, therefore, necessary to mount that gear on the bogie frame and to provide a compensating device to allow for deflection. This design has been tested on a trailer car on the Piccadilly Line but, under certain conditions of track and curvature, its riding qualities were found to be inferior to the previous arrangement, so that it was withdrawn.

Attention has also been paid to axlebox suspension, since a suitable design, used in conjunction with an appropriate bolster, would result in the complete bogie being rubber-suspended, and all the present suspension wearing parts eliminated. In the standard system of suspension, the axlebox is carried in horn guides, that is, openings in the bogie frame which, like the sides of the box, are fitted with manganese liners. The axlebox supports the bogie by a laminated spring carried off the bogie side frame through auxiliary springs and hangers. The centre of the spring rests on top of the axlebox and its buckle fits into a suitable recess in the top of the axlebox. Adjustment for wheel wear is made by screwing the nuts on the auxiliary spring hangers up or down. Several designs of rubber axlebox suspension were considered, but found to be impracticable, partly due to the high cost, but mainly owing to the size of the rubber unit which was necessary to carry the loads concerned.

In conjunction with Metalastik, Limited, however, a design was evolved using chevron rubbers, i.e., V-section pieces bonded to suitably-shaped plates. This design, being compact, can be located in line with the centre of the axlebox bearing in a very simple manner, as shown in Figs. 7 and 8. The entire axlebox, complete with the chevron mountings, is placed in a yoke casting which is bolted to the bogie side frame. To allow for adjustment for wheel wear, this yoke is pivotted at one side and is bolted through slots at the top and opposite side. A screw adjustment is provided so that it may be raised or lowered when slacked off from the bogie frame. With this design the side frame deflection was limited to $\frac{1}{2}$ in., as it was considered that to give a greater deflection would have caused complications. In any case the bolster rubbers could, if required, be given increased deflection to compensate for the reduced deflection of the side frame.

Following experimental test running, a car set of this design was fitted to a pre-1938 tube-stock trailer car, which had already been supplied with the rubber bolster illustrated in Figs. 3 and 4 for service trials. The tests showed that this type of axlebox suspension behaved very satisfactorily, vibrations due to rail joints being noticeably damped out. In the normal way, with the standard form of laminated suspension, the spring cannot respond quickly enough to absorb rail-joint vibration. This type of axlebox assembly, therefore, greatly reduces the dead-load impacts on the bearings as well as on the axle. It is also considered that the high-frequency vibration to which the axle is at present subjected, due to the greater rigidity of roller bearings now standard on London Transport's axleboxes, will be damped out. It has been suggested that these high-frequency vibrations may be responsible for incipient fractures of axles.

From these experiments and trials, it is considered that the best arrangement is the design of bolster shown in Figs. 3 and 4, together with the chevron axlebox suspension shown in Figs. 7 and 8. A further set of these axlebox suspensions has been fitted to the District Line car, so that both the axlebox and bolster suspension can undergo extended running tests in passenger service.

While an accurate appreciation of the financial aspects of these assemblies has yet to be made, depending on the life of the rubber units, a preliminary investigation at a time when price levels were high indicated that the cost per bogie was approximately 50*l.* more than for the standard arrangement. Based on the past six years' experience with bolster rubbers, it is anticipated that the life of the rubber units will be of the order of ten years, if not longer. On this assumption the saving in maintenance would more than compensate for the extra initial cost.

INDUSTRIAL X-RAY VIEWING LANTERN.—A high intensity viewing lantern for industrial X-ray films has been designed by Ilford, Ltd., Ilford. The illuminant consists of a 140-watt sodium vapour lamp, which operates in a vacuum jacket and gives an intensity of 1,250 foot-lamberts. This can be reduced by a rotatable baffle for viewing films of lower density. The lamp is operated from a specially designed ballast which gives an initial voltage of 500 volts decreasing to about 200 volts after switching on. The light output is monochromatic and yellow in colour, thus providing the visual acuity necessary for the observation of fine detail.

JUVENILE LECTURE OF THE ROYAL AERONAUTICAL SOCIETY.—The custom previously observed by the Royal Aeronautical Society of arranging an annual lecture principally intended for young people is to be revived. On this occasion, the lecturer, Sir Leonard Bairstow, C.B.E., F.R.S., will speak on "The Fun of Finding Out in Flying" at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W.1, on Thursday, January 7, 1954, commencing at 3 p.m. The lecture will be illustrated by lantern slides and model aircraft. Tickets of admission may be obtained free of charge from the secretary of the Society, 4, Hamilton-place, London, W.1.

TRADE PUBLICATIONS.

Fabrications in Steel Plate.—A brochure issued by Whessoe, Ltd., Darlington, gives a survey of their activities in the oil, chemical, gas and other industries. All plant is fabricated from steel plate.

Industrial Hand Cleanser.—Industrial Soaps Limited, City Soap Works, Green Bank, London, E.1, have sent us a sample of their Rex industrial hand cleanser, and a leaflet of instructions for its use. They state that it will clean the most heavily soiled hands quickly.

Molybdenum Disulphide Lubricants.—The Ragosine Oil Co., Ltd., Ibex House, Minories, London, E.C.3, have issued a leaflet describing recent additions to their range of lubricants, including silicone greases, containing molybdenum disulphide.

Swing-Hammer Shredders.—An illustrated booklet issued by British Jeffrey-Diamond, Ltd., Wakefield, Yorkshire, gives specifications and detailed descriptions of the operation and construction of their swing-hammer shredders for reducing fibrous materials.

Design, Development, Repair, and Testing Facilities for the Aircraft Industry.—Flight Refuelling, Ltd., Tarrant Rushton Airfield, Blandford, Dorset, have issued a brochure describing the services they can offer to the aircraft industry, which include research, design and development; modifications and conversions; airframe component construction; repair and overhaul of aircraft and equipment; and structural, functional and flight testing.

Energy Regulators.—The first of four data sheets issued by Sunvic Controls, Ltd., 10, Essex-street, Strand, London, W.C.2, deals with their energy regulators. These effect their control by switching the supply on and off repeatedly, the ratio of the two times determining the average power input. The largest type can deal with loads up to 6 kW at 230 volts, alternating current. The leaflet also gives wiring diagrams and characteristic curves.

Vacuum Pump and Accessories.—The second and third of the leaflets issued by Sunvic Controls, Ltd., give details of their vacuum pumps and accessories. Rotary and oil diffusion pumps will give vacua down to 10^{-6} mm. of mercury. Gauges, flap valves and relays are also described.

High-Speed Graphic Recorders.—The fourth leaflet issued by Sunvic Controls, Ltd., 10, Essex-street, London, W.C.2, describes a high-speed graphic recorder. Models are made with up to 16 recording points, and six different speeds, the fastest being 3 in. per minute. The recording point can traverse the 10-in. width of the chart in two seconds for an input change of 500 micro-volts.

Machine Tools.—F. J. Edwards, Ltd., Edwards House, 359-361, Euston-road, London, N.W.1, have published an illustrated catalogue, No. MT853, of machine tools. It gives details of their present stock of new and used equipment.

Commercial Vehicles.—An illustrated brochure which outlines the successful operation, by a number of companies, of their "under-floor" engined vehicles embodying porous-chrome cylinder bores, has been produced by Commer Cars Ltd., Luton, Beds. It refers briefly to the technical aspect of using a chrome-surfaced cylinder bore.

Paint-Spraying Equipment.—B.E.N. Patents Ltd., High Wycombe, Buckinghamshire, have issued a pamphlet announcing the addition of a new spray gun known as type W.H. to their paint-spraying equipment. The weight of the gun, without the syphon cup, is 1¼ lb.

10-in. Stroke Shaping Machine.—Details of the "Royal" 10-in. shaper produced by the Realm Engineering Works Ltd., 267, Whitehorse-lane, South Norwood, London, S.E.25, are given in a pamphlet published by them.

Fittings for Copper Pipes.—A leaflet issued by Fyffe & Co., Ltd., Carolina Port, Dundee, describes their four types of fittings for copper tubes from ¼ in. to 8 in. bore. A wide range of shapes is available and all fittings comply with B.S. 864.

Lubricating Textile Machinery.—Tecalemit, Ltd., Plymouth, have issued a leaflet describing their Tecalemit-Bijur centralised system of lubrication specially designed for textile machinery. It is claimed that the system reduces oil consumption and also clogging of the oil with dust.

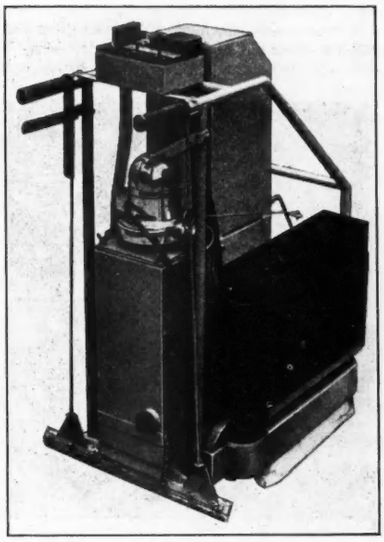
Safety Lock Washers.—The Palnut Company, Ltd., 28, Elder-row, Brighton, 1, have sent us a pamphlet showing details of their "Palnut" safety lock washers used on the connecting rods of the Ford Consul and Zephyr engines.

Machine Tool Vice.—A 6-in. heavy-duty machine vice, mounted on a swivel type base graduated in degrees, is described in a leaflet issued by the Realm Engineering Works Ltd., 267, Whitehorse-lane, South Norwood, London, S.E.25.

Electrical Plant for Wool Industry.—The English Electric Co., Ltd., Stafford, have published an illustrated brochure entitled "The Power Behind the Wool Industries," which describes the generating plant, switchgear and other equipment they manufacture for this purpose.

INDUSTRIAL FLOOR-CLEANING MACHINE.

A BATTERY-DRIVEN floor-cleaning machine, known as the C.50A and shown in the accompanying illustration, has been developed by S. R. Cowlard, Limited, Birmingham-road, Bromsgrove, Worcestershire. The sole selling agents are Industrial Colloids, Limited, Altrincham, Cheshire. Operated by one man, the machine is capable of scrubbing and drying 400 to 500 yards an hour, and is particularly suitable for cleaning greasy and oily floors. It comprises a cast-aluminium machined base, carried on an adjustable front castor and two rear wheels, on which is mounted a divided tank. One half of the tank, with a capacity of 4 gallons, contains a clean water and detergent solution, and the other half receives the dirty water. On either side of the tank are two 12-volt Exide traction batteries which provide power for a 1-h.p. B.T.H. heavy industrial motor



driving twin rotary brushes, and a ½-h.p. 11,200-r.p.m. motor and fan, which exhausts air from the dirty-water tank. The motor switches and control levers for the water and suction are mounted on the handles of the tubular-steel framework.

The cleansing solution is fed by gravity from the tank to a sprinkler system immediately ahead of the brushes. As the machine passes over the scrubbed portion of the floor, the dirty water is piled up by trailing "squeegee" rubbers attached to a suction bar at the rear of the machine, and is sucked up into the dirty-water tank. The clean floor, it is stated, is dry within a few seconds of the machine's passing.

The twin brushes are aluminium-backed and, together, provide coverage over a width of 19 in. Shaped like a four-pointed star with a cut-out centre, the two brushes intermesh, and the cut-out centres prevent clogging and allow for some self-cleaning. They are easily interchangeable, being retained and locked in keyhole slots cut in two rotating base plates driven, through a simple reduction gear, by the motor. The brush pressure can be adjusted so that only the tips of the bristles are in contact with the dirty surface.

For tackling a floor coated with thickly-compacted oil and grease, the machine can be fitted with heavy industrial scratch brushes with self-cleaning steel prongs. Having broken down the compact into dust, the wet scrubbing brushes are employed. Since the slurry is contained within the floor area covered by the machine, there is no risk of accident.

1955 WORLD PETROLEUM CONGRESS.—Arrangements have been made for the Fourth World Petroleum Congress to be held in Rome from June 6 to 15, 1955. Further particulars will be obtainable later from the Secretary of the Institute of Petroleum, 26, Portland-place, London, W.1.

NOTES ON NEW BOOKS.

Introduction to Elliptic Functions, with Applications. By F. BOWMAN. English Universities Press, Limited, St. Paul's House, Warwick-square, London, E.C.4. [Price 12*s.* 6*d.*]

THIS book provides an introduction to the Jacobian elliptic functions and to some of their chief applications. These functions are defined at the outset in such a way as to bring out their doubly periodic character and to contrast it with the singly periodic circular functions, which are shown to constitute degenerate cases of the former. Various properties of, and relations between, the Jacobian elliptic functions are then derived on the basis of these definitions. Legendre's standard forms of the elliptic integrals of the first, second and third kinds are considered next, together with their properties and those of the corresponding complete elliptic integrals. Historically, the elliptic integral of the first kind was originally encountered in the calculation of the period of finite oscillations of a pendulum; the elliptic integral of the second kind arose in connection with the problem of the rectification of the ellipse. Having dealt with these and other applications in which the argument is real, attention is directed to elliptic functions with imaginary and complex arguments. In the next two chapters conformal representations involving elliptic functions are discussed and illustrated by applications to two-dimensional problems in electricity and hydrodynamics. Chapter VIII deals with elliptic integrals of the second and third kinds when the argument is complex and a few examples of conformal representation in which they appear. Chapter IX explains methods due to Cayley and others for the reduction of integrals to the standard forms of Legendre. The concluding chapter consists of a discussion on a degenerate hyperelliptic integral. Worked examples are given throughout the text and sets of examples to serve as exercises at the end, and during the course of the chapters. In the brief bibliography, mention is made of the more important standard works on elliptic functions, though the list of numerical tables omits the 1931 Emde reprint of Legendre's table of normal elliptic integrals of the first and second kind and the Greenhill-Hippisley tables included in the *Smithsonian Mathematical Formulæ*. Most engineers will find all the information concerning elliptic functions they are likely to need clearly presented in this handy little volume.

Interviewing for Selection.

National Institute of Industrial Psychology, 14, Welbeck-street, London, W.1. [Price 2*s.* 6*d.*]

IT would seem reasonable to suppose that in interviewing a candidate for employment, the procedures followed would hardly be identical in the cases of what this brochure calls a "school-leaver" candidate and one of mature years with technical attainments and some industrial or applied-science experience. It is stated that the object of the interview is to throw light upon the "intellectual and social skills" of the candidate, on his "personal energy and motivation," and on his technical knowledge and experience. The case of an applicant for the directorship of, say, an important research association might be expected to rest mainly on this latter class of qualifications, whereas the school-leaver would have to make his cases in virtue of his "intellectual and social skills" or, if the expression be preferred, on his "personal energy and motivation." In both cases, it may be assumed that the interviewer would have prior information about the earlier career of the applicant—in one case, at school; in the other, in practical life. This prior information is, however, not sufficient in itself to enable the suitability of a candidate to be determined; if it was, there would be no purpose in the interview. In broad terms, the object aimed at in seeing, and talking to, the candidate is to weigh up his personality. The aim of this brochure is to explain how that end is to be attained, but some of its statements may not find universal acceptance. Stress is laid on the importance of school history, even in the case of older candidates. It is stated that "attitudes, motivation and other key elements

of personality are very largely determined" at school, but it would seem likely that a boy who found school cricket a bore carried the disinclination with him when he entered school. The school revealed it; did not determinine it. Remarks of this sort, however, verge on the province of the psychologist, which it is dangerous to enter. One may at any moment find oneself checkmated by an incomprehensible terminology. Useful suggestions are made about the conduct of interviews, through readers may not agree that all are valuable. The advantages of putting the candidate at ease are obvious, but the recommendation that he should be invited to smoke is not attractive. Such a procedure would frequently not be altogether seemly; certainly not in the case of the more junior applicants. This pamphlet may be read with interest and some profit, if not always with full acceptance, by anyone concerned with interviewing candidates for appointments

CONTRACTS.

THE ALUMINIUM WIRE AND CABLE CO. LTD., 30, Charles II-street, St. James's-square, London, S.W.1, have obtained an order worth about 750,000 dols., for the supply of steel-cored aluminium conductor to the British Columbia Electric Railway Co., Ltd., Canada, for delivery during the first half of 1954.

JAMES KILPATRICK AND SON, LTD., Paisley, have received the contract for the complete electrical services for King Feisal's new Royal Palace at Baghdad. The value of the work is about 200,000*l.*, and it is expected to begin early next year.

ELECTRIC AND MUSICAL INDUSTRIES LTD., Hayes, Middlesex, have received an order from the Ministry of Communications of the Argentine for 32 magnetic tape recorders similar to those used by the British Broadcasting Corporation, and for large quantities of recording tape. It is understood that the equipment will be used in Argentina to develop broadcasting facilities throughout the country.

JOHN FOWLER & CO. (LEEDS) LTD., have obtained an order from the War Office for a number of their 95-h.p. Challenger Diesel crawler machines. The first of these machines was delivered, after extensive testing of prototypes, in December, 1950. A similar machine was delivered two months later to the Military Experimental Engineering Establishment for further extensive testing. On completion of these tests a substantial order was placed for these machines, fitted with hydraulic angledozers and winches. The new order is for the same machine fitted with hydraulic angledozers and the firm's logging winches, or, alternatively, power-controlled units.

MARPLES, RIDGEWAY AND PARTNERS, LTD., 2, Lygon-place, London, S.W.1, are to construct a new 715-ft. dry dock for Brigham and Cowan, Ltd., South Shields. Work is being started immediately and it is anticipated that the dock will be ready within two years; it will accommodate oil tankers of a deadweight capacity of up to 38,000 tons. The all-welded flap-type dock gate is to be made by HEAD, WRIGHTSON & CO. LTD., Thornaby-on-Tees.

PALMERS HEBBURN CO., LTD., Hebburn-on-Tyne, have obtained the contract for the refitting of the Post Office cable-laying ship Monarch. During the refit, alterations will be made to the vessel to enable her to carry out the projected laying of a submarine telephone cable across the Atlantic. The work of refitting will take about six weeks.

THE SCOTTISH MACHINE TOOL CORPORATION LTD., Johnstone, have received an order to supply a 6 ft. 3 in. heavy-duty wheel lathe for the St. Rollox Works, Scottish Region, British Railways, Glasgow.

LABORATORY AND INDUSTRIAL DISINTEGRATORS.

EQUIPMENT for crushing, pulverising or shredding materials, which can also be used for homogenising and blending, designed by the Rietz Manufacturing Company, Santa Rosa, California, U.S.A., is now being manufactured under licence in the United Kingdom by George Scott and Son (London), Limited, Artillery House, Artillery-row, London, S.W.1. Two versions of the Rietz disintegrator, both operating on the same principle, and capable of handling wet and sticky materials without clogging, are to be produced. The laboratory angle disintegrator, shown in the accompanying illustration, can be supplied with rotor diameters ranging from 4 in. to 12 in. with driving motors from ½ h.p. to 30 h.p. A larger vertical disintegrator for industrial use is available with 8-in. to 24-in. diameter rotors and 5-h.p. to 400-h.p. driving motors. The vertical layout has the advantage of occupying less floor space.

In the vertical machine, a self-contained driving motor is mounted above, and directly coupled to, a vertical rotor shaft which is supported at each

end in heavy-duty ball-bearings. The rotor consists of a number of arms each having a broad face, or hammer, of manganese or stainless steel, hardened on the leading edge. A perforated heat-treated carbon-steel screen completely surrounds the swept area of the rotor. Differential discharge pans are carried below the robust cast-iron body, which supports the rotor shaft.

The material is fed in by gravity at the top of the rotor shaft, and is thrown outwards by centrifugal force against the screen. The primary product is forced through the screen and out through the main discharge outlet. The secondary product remains inside the screen, the size of which can be varied to give the required particle size, and is discharged through the secondary outlet. The use of a large 360-deg. screen, it is claimed, produces a uniform finished particle size and results in a low temperature rise and high efficiency. For dealing with material that is too large to be fed directly into the disintegrator, such as green bone, wood, meat, cork, ore, pulpboard, vegetable waste, and asbestos shingle scrap, a pre-breaker is made. This machine, operating at high torque at relatively low speeds, is gravity-fed through a large hopper. Deflectors carry the material horizontally through a series of anvils and hoppers. It is available in diameters ranging from 6 in. to 18 in., in lengths from 30 in. to 48 in., and with power units from ½ h.p. to 100 h.p.

BOOKS RECEIVED.

United States National Bureau of Standards. Applied Mathematics Series No. 27. *Tables of* 10^x. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 3.50 dols.]

The British Electrical and Allied Industries Research Association. Technical Report G/T247. *Contactors: Contact Wear and Heating Tests on* 400 *V*, 75 *A, Three-Phase Models.* By H. W. BAXTER. [Price 6*s.*] No. G/T263. *Contact Wear of* 440 *V*, 150 *A, Three-Phase Contactors.* By H. W. BAXTER and B. HOPWOOD. [Price 7*s.* 6*d.*] No. G/XT135. *Air-Break Arc Chute Circuit-Breakers: Discussion of Published Information on Modern Types.* By M. P. REECE. [Price 15*s.*] No. T/T48. *Meter and Instrument Jewels and Pivots. Fourth Interim Report.* By G. F. SHOTTER. [Price 30*s.*] No. Z/T88. *The General Solution of Special Case of a Non-Linear Differential Equation.* By H. GOLDENBERG. [Price 3*s.*] No. Z/T93. *The Self-Adjusting Arc and Controlled Arc Welding Processes. A Review of Published Information.* By W. G. HULL and J. C. NEEDHAM. [Price 7*s.*] Offices of the Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.

Engineers as Writers. Edited by WALTER J. MILLER and LEO E. A. SAIDLA. D. Van Nostrand Company, Incorporated, 250, Fourth-avenue, New York, U.S.A. [Price 4·25 dols]; and Macmillan and Company, Limited, St. Martin's-street, London, W.C.2. [Price 32*s.* net.]

Technische Messungen bei Maschinenuntersuchungen und zur Betriebskontrolle. By PROFESSOR A. GRAMBERG. Seventh revised edition. Springer-Verlag, Reichpietschufer 20, Berlin W.35. [Price 36 D.M.]

Kinematische Getriebesynthese. By DR. RUDOLF BEYER. Springer-Verlag, Reichpietschufer 20, Berlin W.35. [Price 36 D.M.]

Ministry of Transport and Civil Aviation. Railway Accidents. Report on the Collision which Occurred on 24th May, 1953, between Forest Gate and Manor Park in the Eastern Region, British Railways. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6*d.* net.]

Writing English. By D. J. GRAHAM-CAMPBELL. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 8*s.* 6*d.*]

Canada. Department of Mines and Technical Surveys. Mines Branch. Technical Paper No. 5. *Effect of Germanium on the Transformation of White to Grey Tin at Comparatively Low Temperature.* By R. R. ROGERS and J. F. FYDELL. No. 6. *The Determination of Uranium in Concentrates by the Fluorphotometric Method.* By J. B. ZIMMERMAN, F. T. RABBITTS and E. D. KORNELSEN. The Director, Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada. [Price 25 cents each.]

Interviewing for Selection. National Institute of Industrial Psychology, 14, Welbeck-street, London, W.1. [Price 2*s.* 6*d.*]

The Strength Properties of Plywood. Part I. Comparison of 3-Ply Woods of a Standard Thickness. Forest Products Research Bulletin No. 29. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1*s.* 3*d.* net.]

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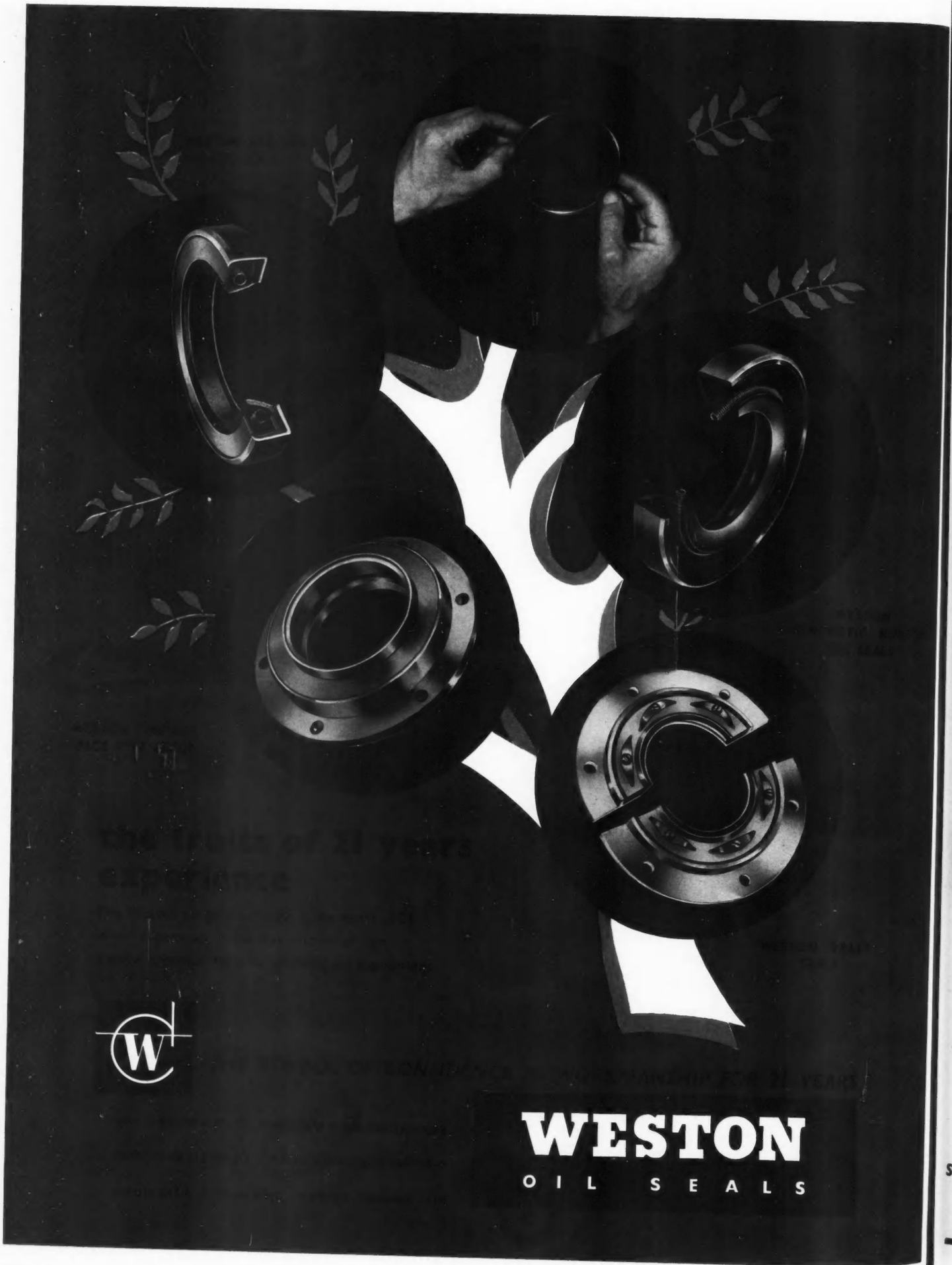
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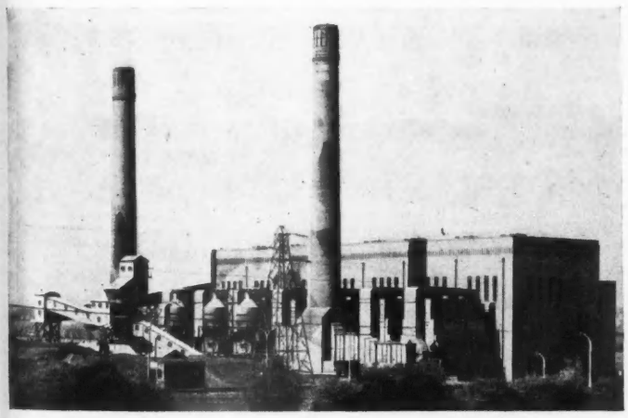

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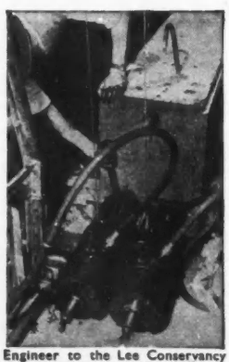

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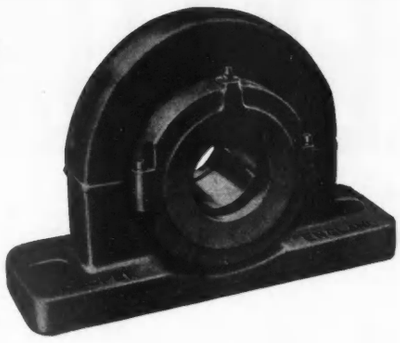

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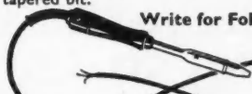

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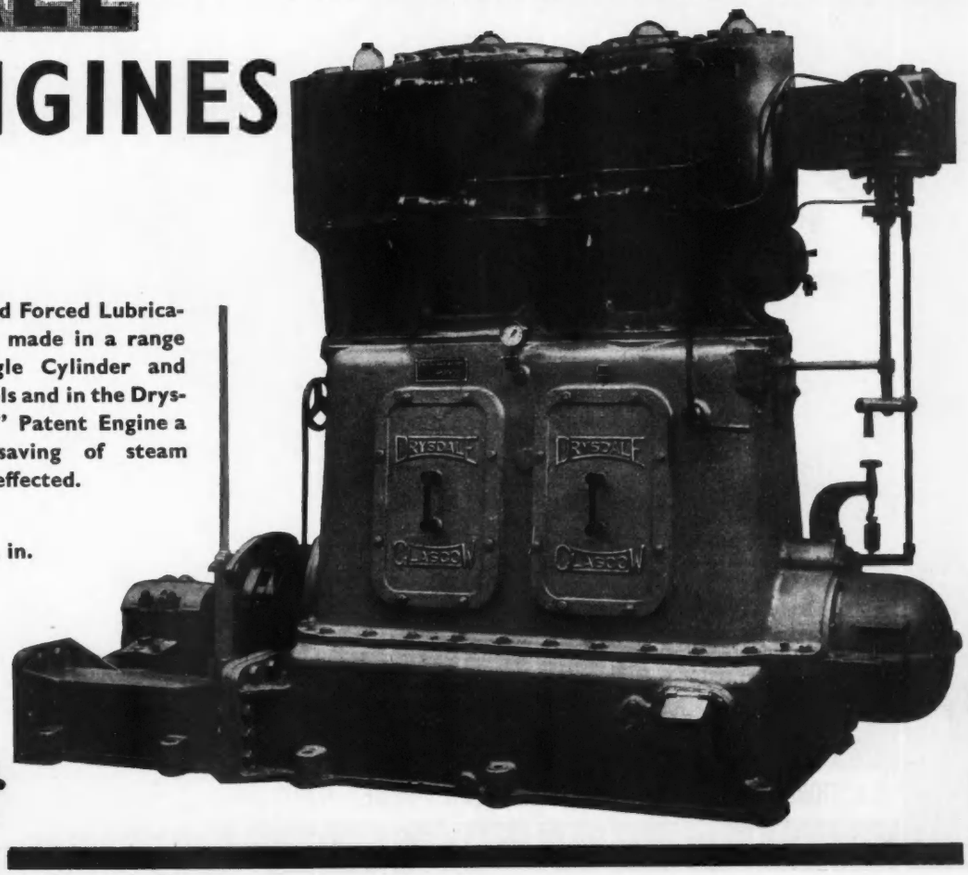

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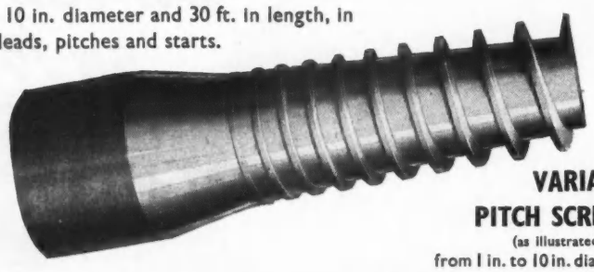

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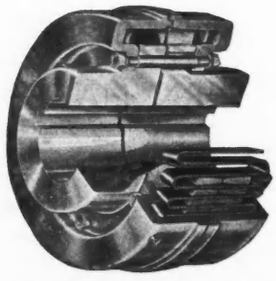

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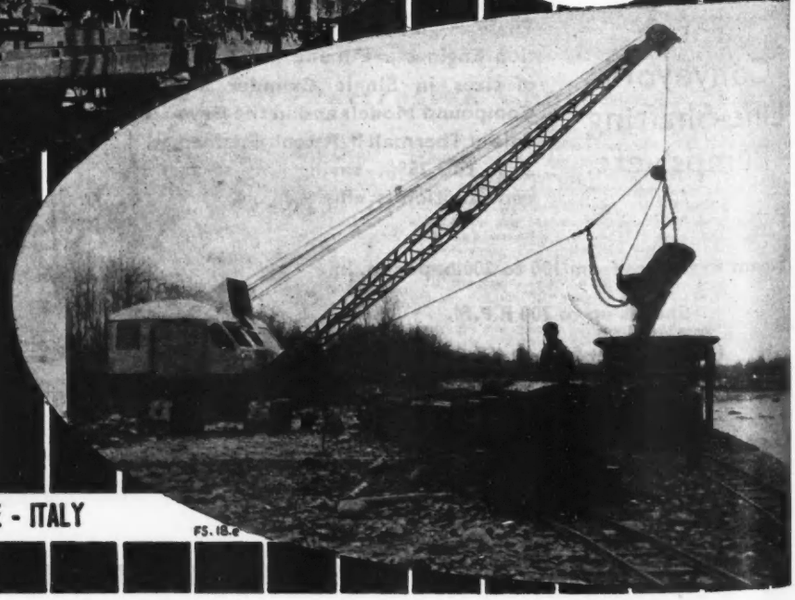

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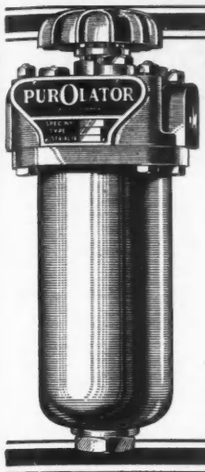

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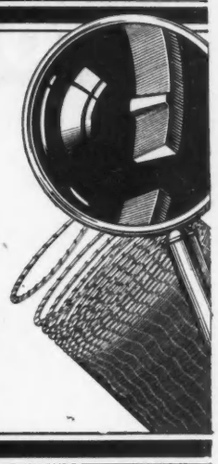

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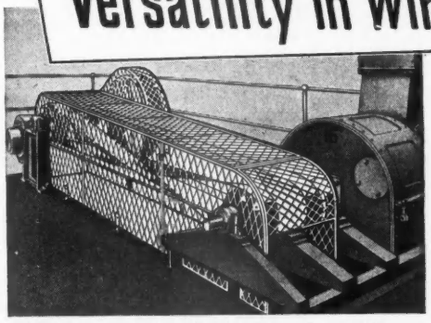

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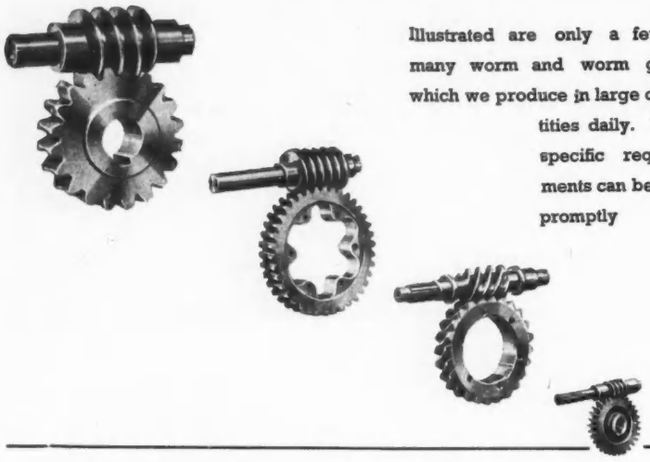

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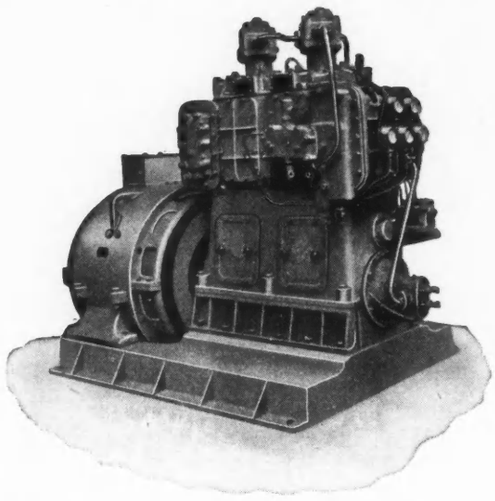

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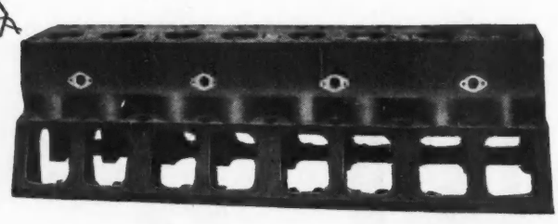

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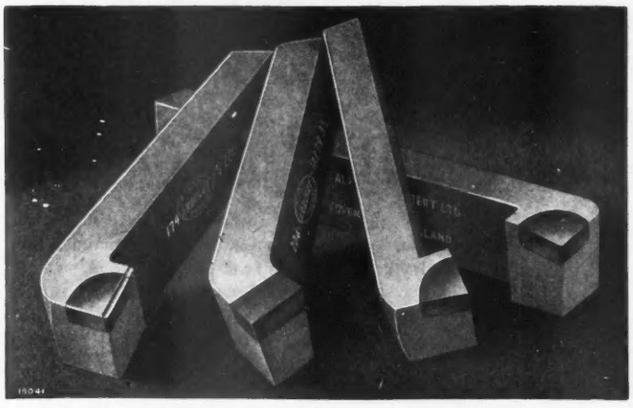

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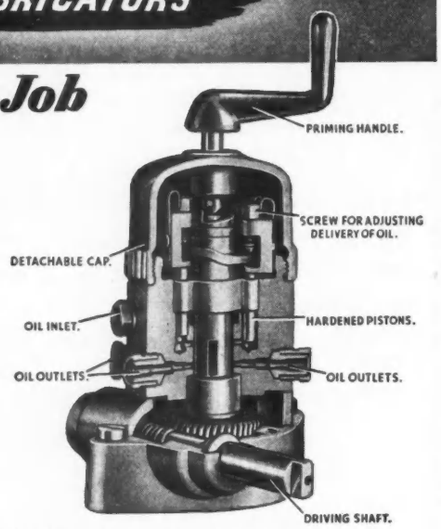

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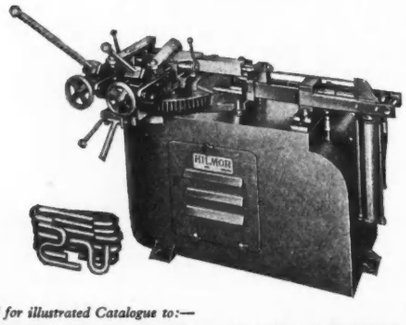

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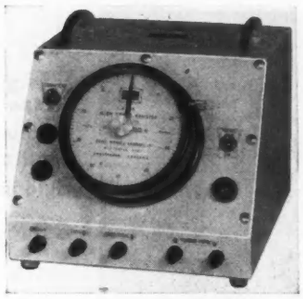

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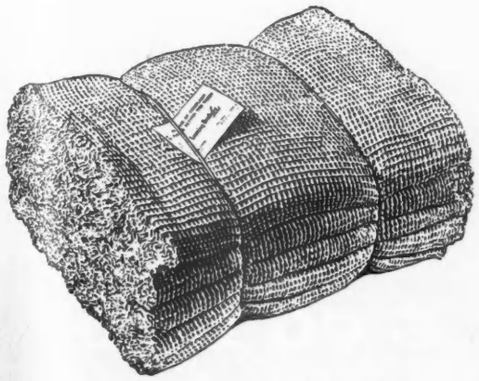

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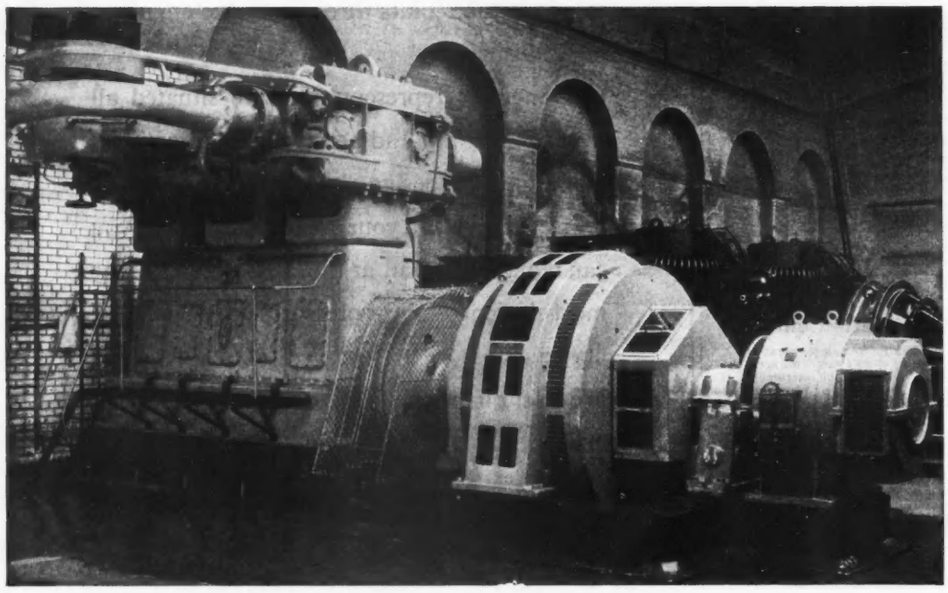

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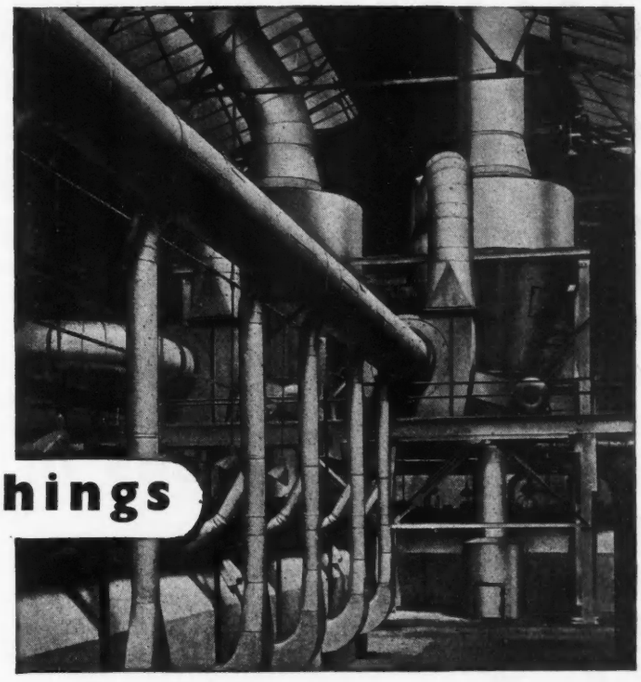

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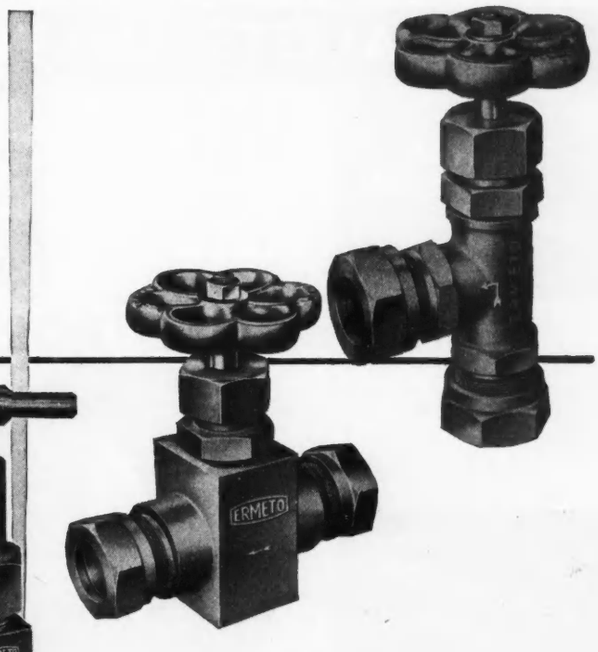

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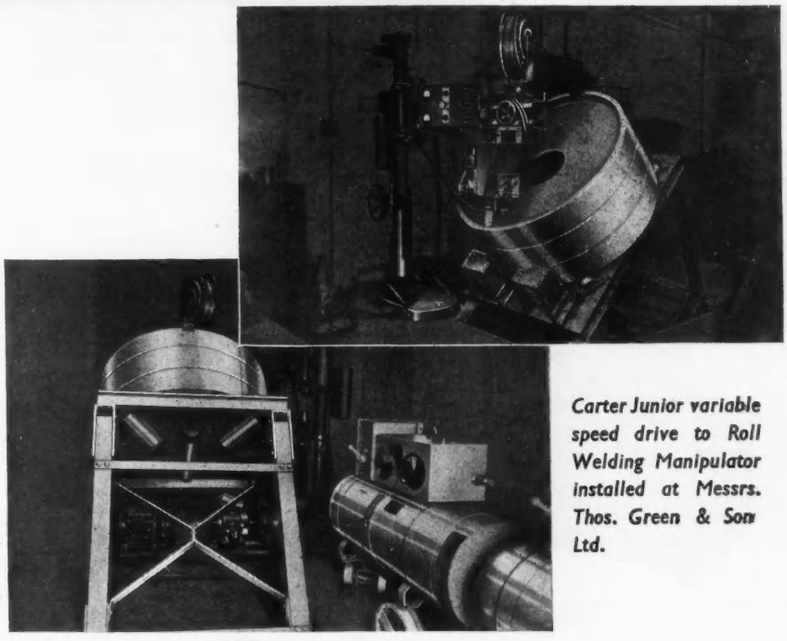

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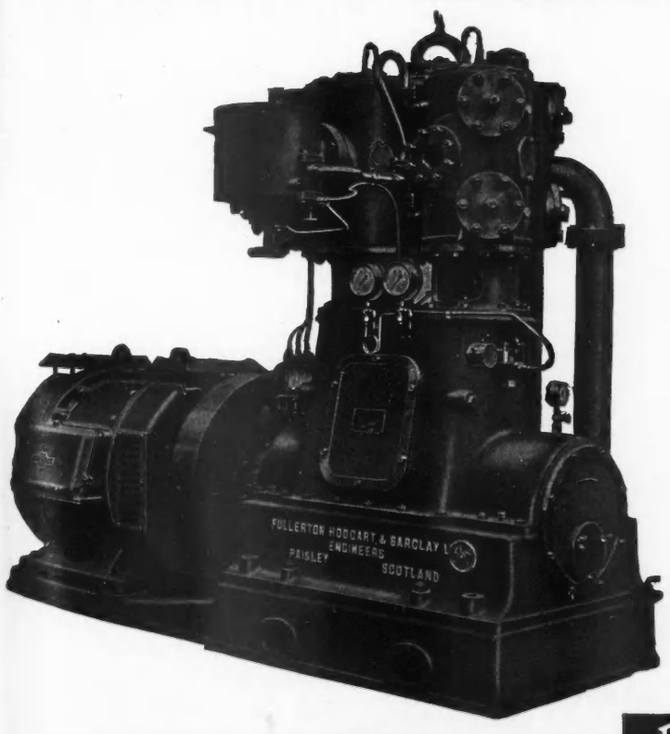

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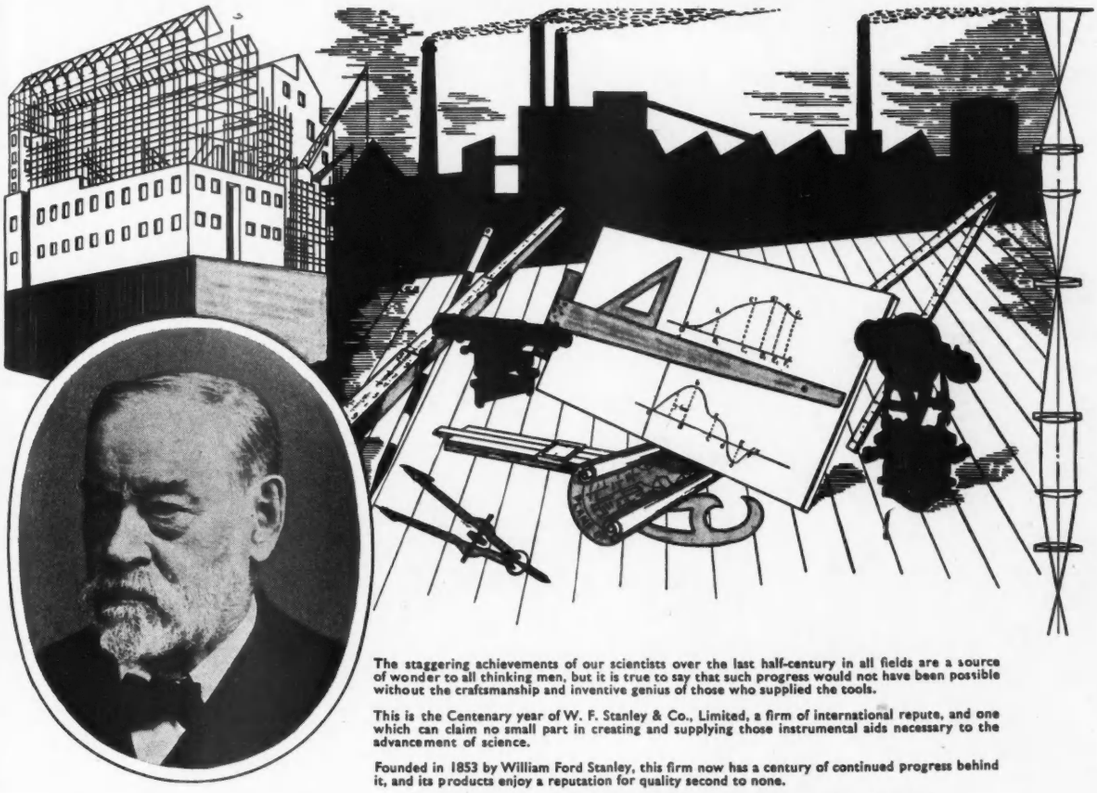
Like a respectable Victorian suitor the male stickleback provides a home before choosing a mate. He undertakes its construction entirely on his own, acting as architect, builder and labourer all in one.

First he selects a suitable site where the water flows freely but not too swiftly. In salt-water he chooses shallows or a rock-pool, reached by the sea only at high-tide. Collecting together pieces of roots and stalks he cements them together with a sticky substance (mucus) from his kidneys. This mucus appears on the stickleback's sides and is removed when he rubs himself against the platform-like structure which he is making. He scatters mouthfuls of sand over this foundation to weigh it firmly down and satisfies himself that his work so far is strong by swimming against it and splashing vigorously.

Then he begins work on the barrel-shaped structure which forms the nest or nursery, working it together in the same way as the platform. He plasters it smoothly inside by swimming in and out and rubbing the mucus from his body on to the walls, where it hardens like varnish. The home is then completely ready to receive his mate and the eggs she will lay.

Φ21



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The staggering achievements of our scientists over the last half-century in all fields are a source of wonder to all thinking men, but it is true to say that such progress would not have been possible without the craftsmanship and inventive genius of those who supplied the tools.

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ELECTRICALLY OPERATED VALVES AND COMPONENTS

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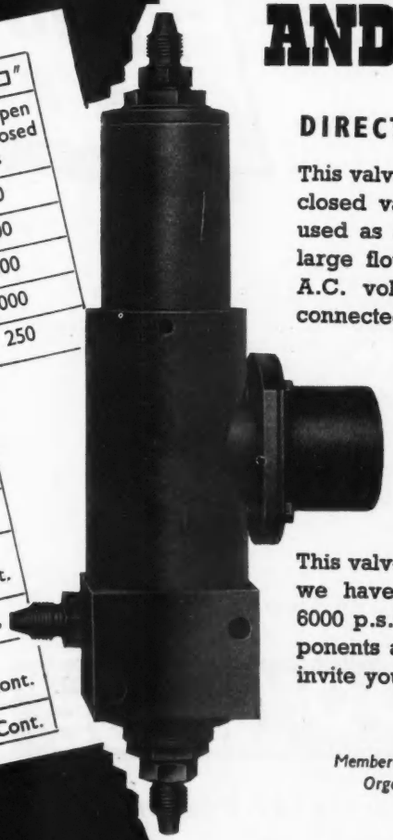
TABLE I

Standard Orifice Dia. Inches	Max. Working Pressure lbs./□" 3-Way Valve	Normally open Normally closed Valves
0.04 Dia.	6,000	6,000
0.06 Dia.	3,000	4,000
0.08 Dia.	1,000	1,500
0.10 Dia.	500	1,000
0.15 Dia.	100	250

TABLE II

Standard Voltage Range (D.C.)	Current Amps.	Rating
22-29	.672	Cont.
75-95 (115 A.C. Rectified)	.268	Cont.
100-120	.174	"
175-195 (230 A.C. Rectified)	.142	Cont.
220-240	.114	Cont.



DIRECT ACTING 3-WAY VALVE B1200 TYPE

This valve may be supplied either as a 3-way valve, a normally closed valve, or as a normally open valve. It may also be used as a pilot valve for operating relay type valves where large flows at high pressures are to be controlled. Where A.C. voltages only are available, suitable full wave bridge connected rectifiers can be supplied with the valves.

Table 1 gives the size of orifices which may be fitted with the corresponding maximum working pressures.

Table II gives the voltage current characteristics for this type of valve. The graph shows the flow characteristics.

This valve is just one of a wide range of valves and components we have developed, suitable for working pressures up to 6000 p.s.i. for Industrial applications. Many of these components are covered by Buxton Flameproof Certificates. We invite you to discuss your project with us.

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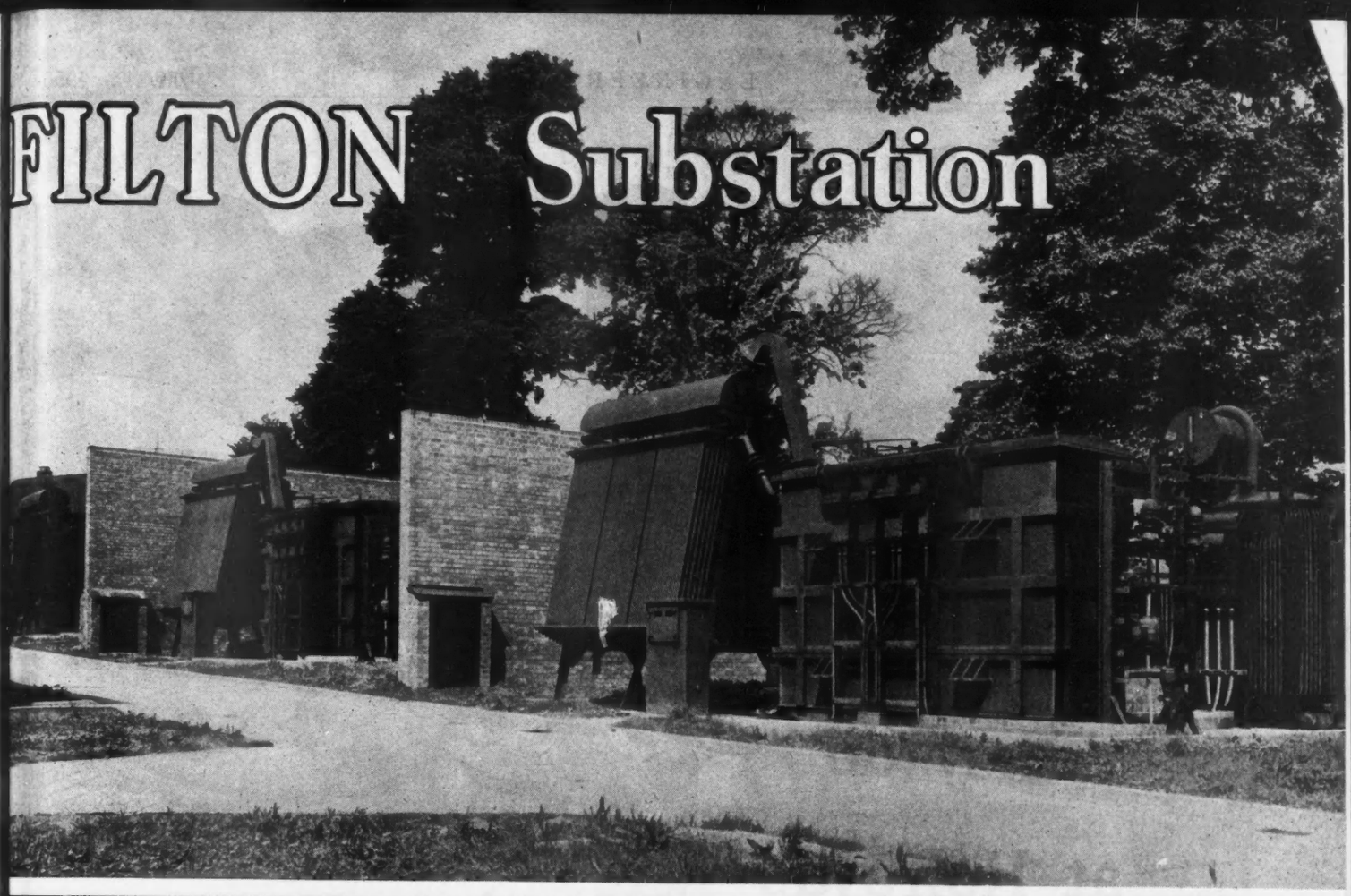

TRANSFORMERS

C. A. PARSONS & Co. LTD.
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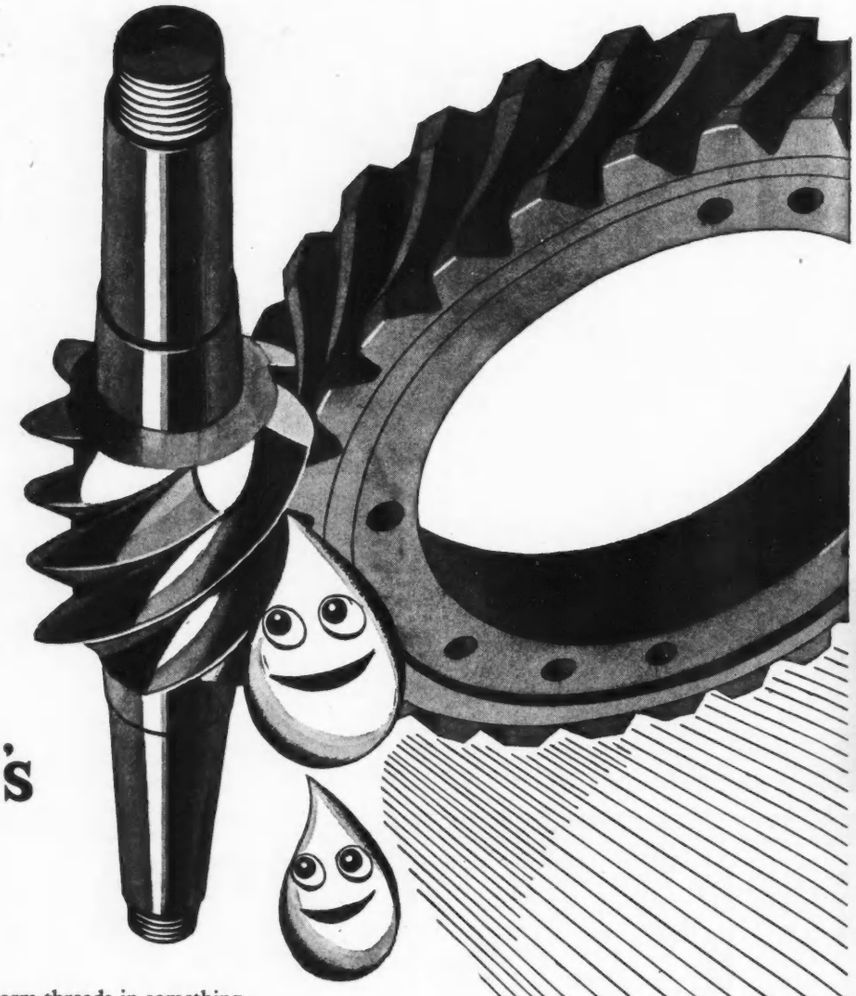
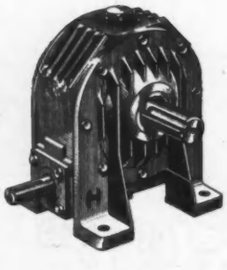
the things they do at Holroyd's



They make their wheel teeth and worm threads in something they call 'basic involute helicoid form, modified to give oil entry gap at contact lines'. They say this gives correct contact and oil film lubrication in fully loaded and deflected positions. They say this helps to make their worms and wheels the very good worms and wheels that they are. Any questions?

They've written a book about it—

about the way they make their worms and wheels, about gear selection and service, dimensions, efficiencies, lubrication and maintenance—all the facts a user needs on Holroyd Worm Gears and Worm Reduction Units. They'll be very glad to send *you* a copy. Their address is John Holroyd & Co. Ltd., Milnrow, Lancs.



QUICK DELIVERIES CAN BE MADE OF ALL

Holroyd WORM GEARS AND WORM REDUCTION UNITS

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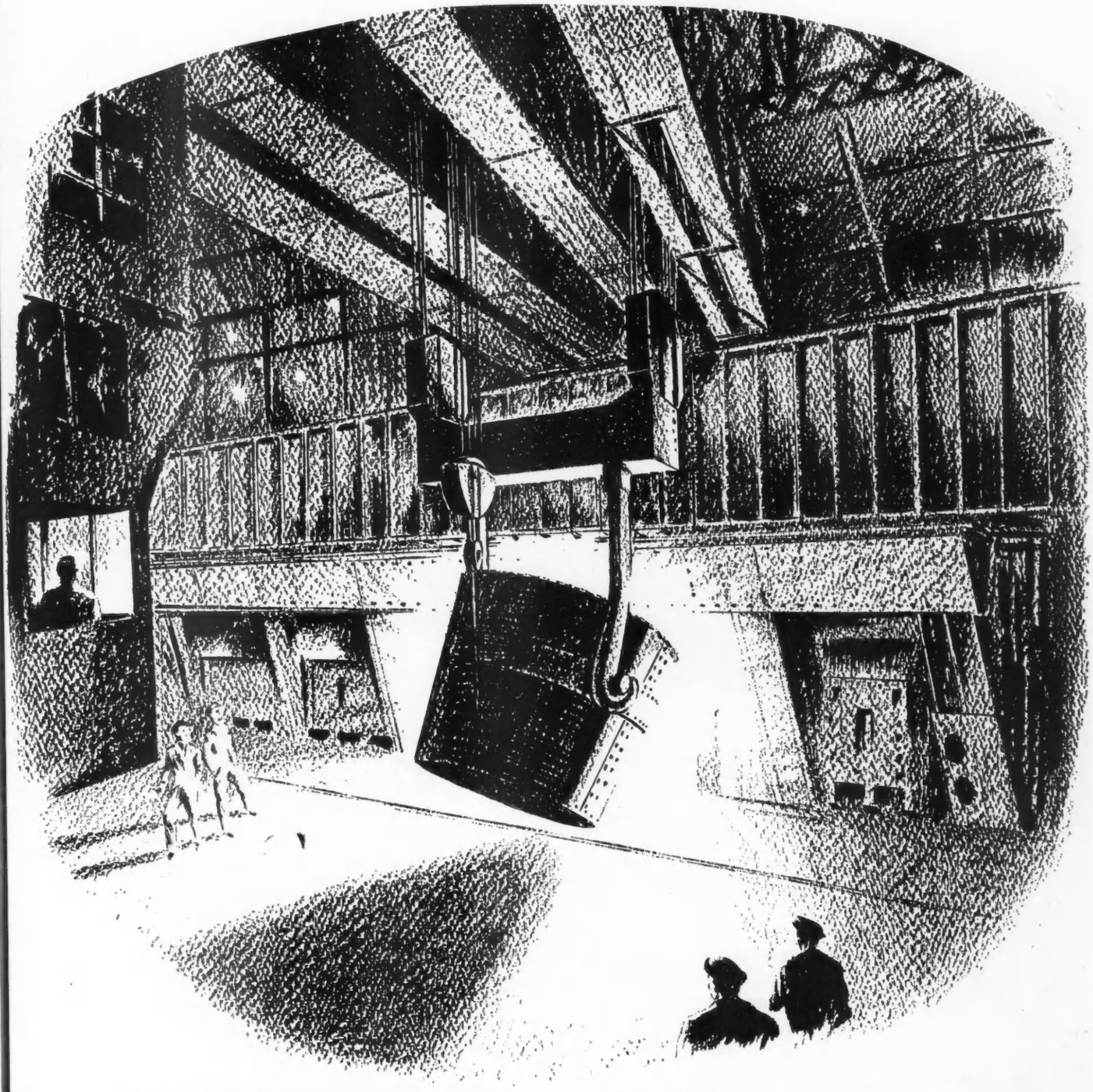

Booth Ladle Cranes are in use in many of the important steelworks throughout the country. Designed for the heaviest duties they reflect the experience of over a century in designing and building cranes of all types for every kind of industrial use.

From a wide experience in designing and building all types of crane installations we should be pleased to submit proposals and designs to suit any requirements.

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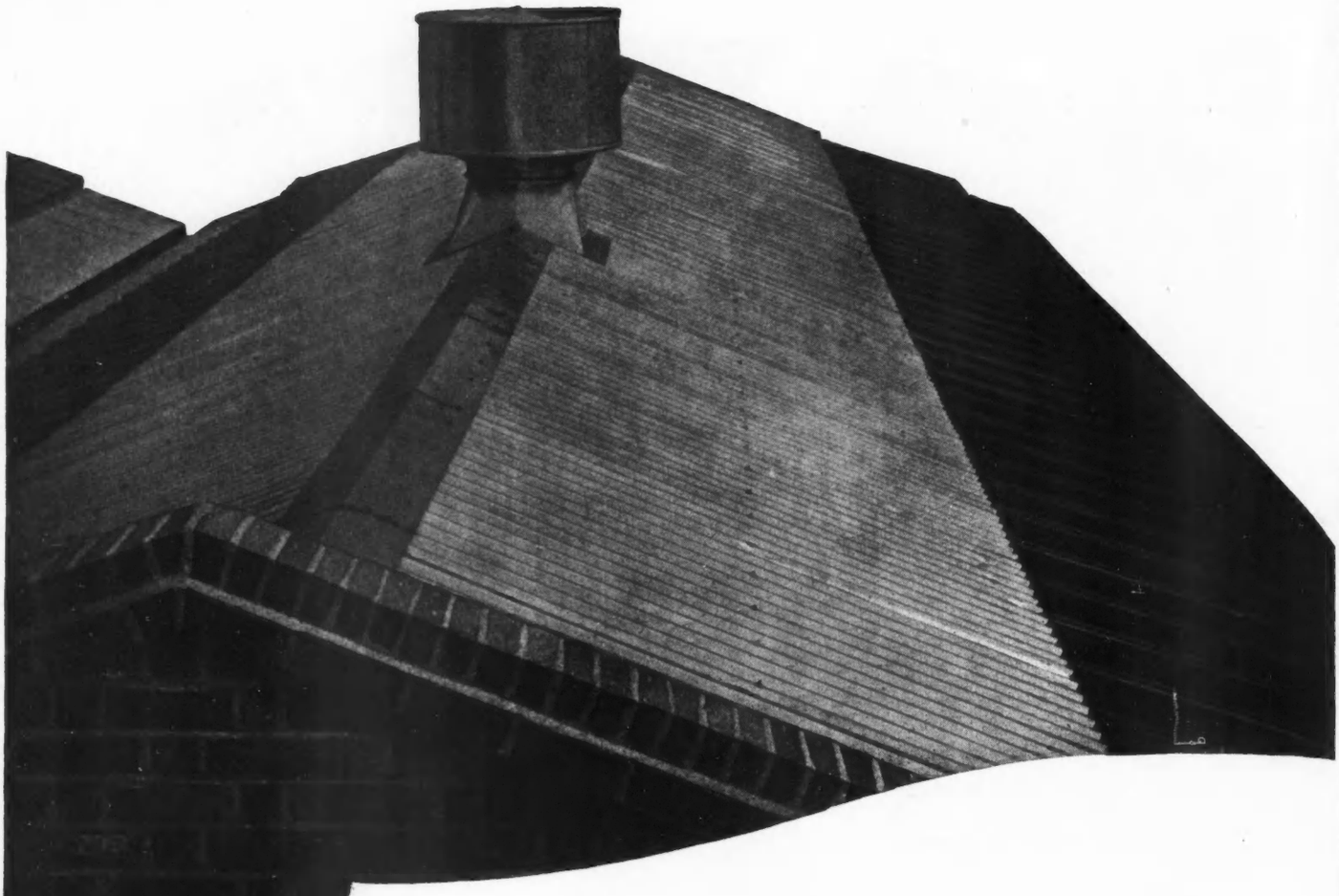

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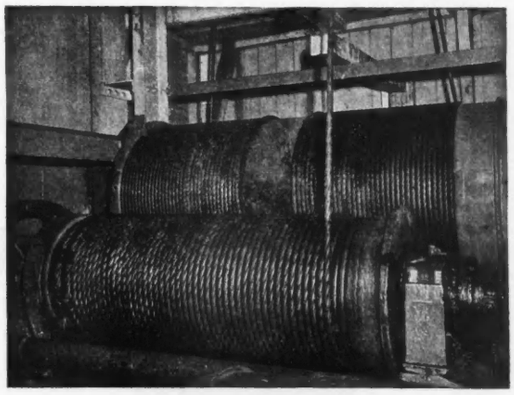
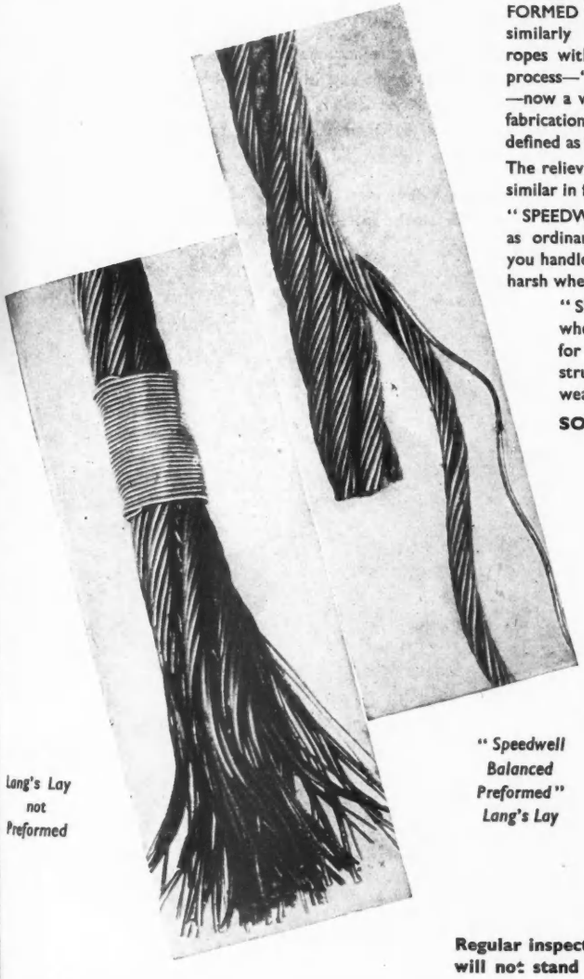
Give your Ropes a chance

"BALANCED PREFORMED"



With acknowledgment to Messrs. Clyde Crane and Engineering Company, Mossend, Lanarkshire.



Lang's Lay not Preformed

"Speedwell Balanced Preformed" Lang's Lay

"SPEEDWELL BALANCED PREFORMED" wire ropes are manufactured similarly to ordinary non-preformed ropes with the addition of one extra process—"BALANCED PREFORMING"—now a well-tried development in the fabrication of wire ropes, and may be defined as follows—

The relieving of the internal stresses in a wire rope by forming the wires and strands into helices exactly similar in formation to the spiral which they will occupy in the finished rope.

"SPEEDWELL BALANCED PREFORMED" wire ropes are made in the same constructions and qualities as ordinary non-preformed wire ropes—both look the same, but the difference becomes obvious when you handle them, particularly if they are Lang's Lay ropes. The ordinary non-preformed rope is lively and harsh whereas the "Balanced Preformed" is dead and docile.

"SPEEDWELL BALANCED PREFORMED" gives excellent results when used for running ropes or where the rope has to be reeved on the job or handled in a confined space, but it is of little benefit for standing ropes, e.g., standing rigging, guys, etc. Quality for quality and construction for construction it is equally as strong. It is slightly more flexible and has the same resistance to crushing wear and corrosion, but has a much higher resistance to fatigue due to bending.

SOME OUTSTANDING ADVANTAGES OF 'SPEEDWELL BALANCED PREFORMED' ARE WORTHY OF NOTE:

1. "SPEEDWELL BALANCED PREFORMED" is free from internal stress.
2. "SPEEDWELL BALANCED PREFORMING" ensures that each strand bears a fair share of the rope capacity.
3. "SPEEDWELL BALANCED PREFORMED" can be put to work at full capacity after a shorter "running in" period.
4. "SPEEDWELL BALANCED PREFORMED" does not tend to kink and can be more easily handled. This particularly applies to Lang's Lay ropes.
5. "SPEEDWELL BALANCED PREFORMED" can be cut without seizing.
6. "SPEEDWELL BALANCED PREFORMED" splices more easily.
7. "SPEEDWELL BALANCED PREFORMED" is reeved on the job more quickly.
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9. "SPEEDWELL BALANCED PREFORMED" is more suitable for reverse bends.
10. "SPEEDWELL BALANCED PREFORMED" does not "hedgehog"—broken wires will lie in position and make the rope safer to handle after usage.
11. "SPEEDWELL BALANCED PREFORMED" will thread through socket shanks or eyes more easily.
12. "SPEEDWELL BALANCED PREFORMED" reduces spinning.

BETTER PERFORMANCE

IMPORTANT WARNING

Regular inspection of preformed rope is essential when the rope is in use. Should wires break they will not stand out but lie in position and can be exceptionally difficult to spot, particularly if the rope is lubricated with a thick dressing.

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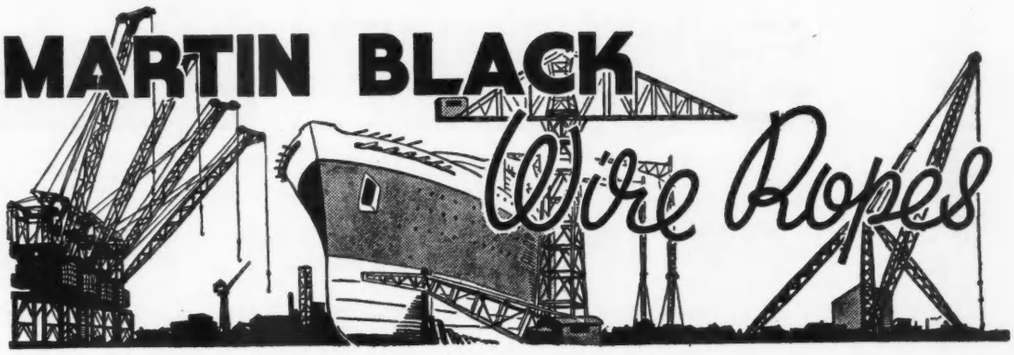

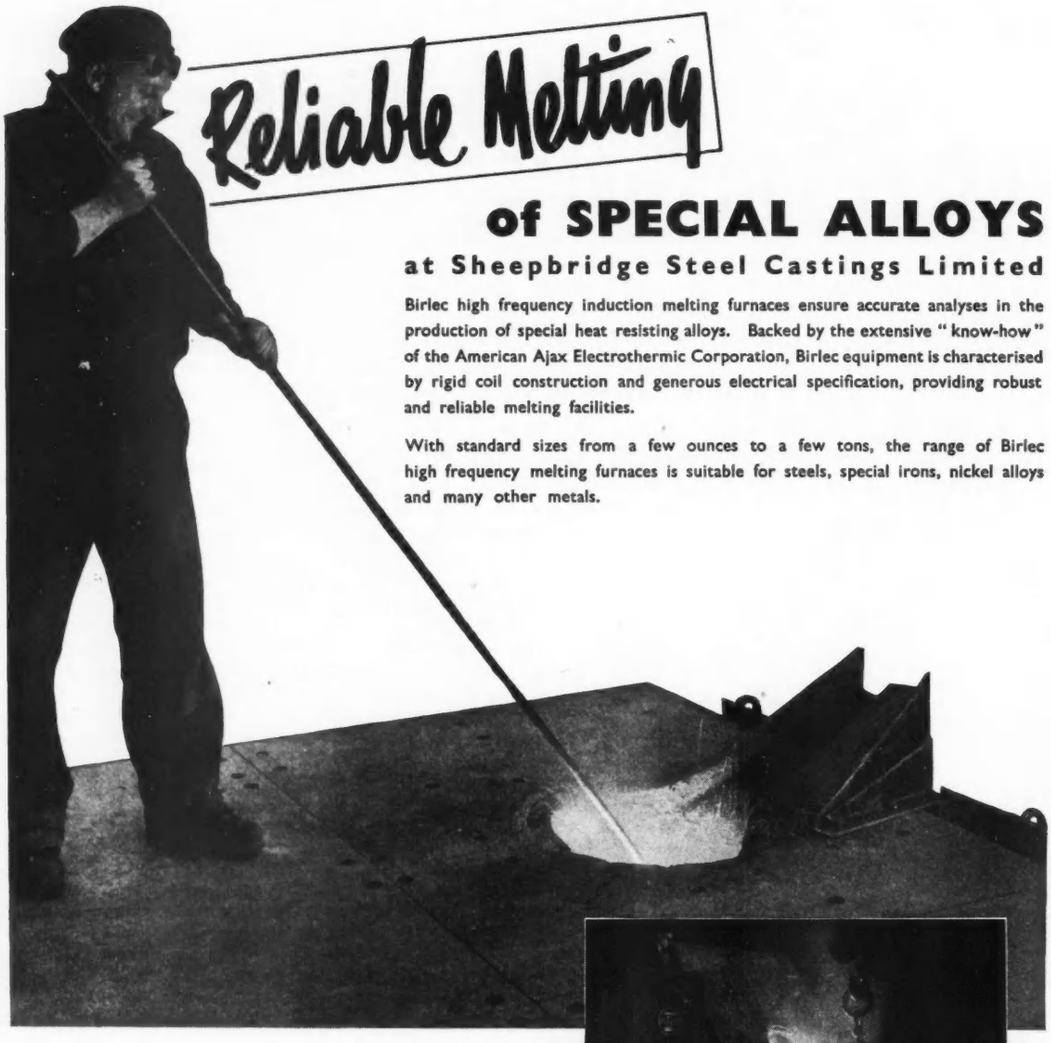

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of SPECIAL ALLOYS

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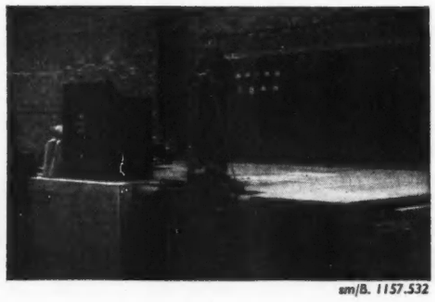
With standard sizes from a few ounces to a few tons, the range of Birlec high frequency melting furnaces is suitable for steels, special irons, nickel alloys and many other metals.

Above: one of the two 10 cwt. furnaces at Sheepbridge Steel Castings Ltd. The furnaces are powered by a 400kW high frequency motor alternator generator which is connected to either furnace through a change-over switch.

Inset top: pouring one of the furnaces; hydraulic tilting mechanism is used.

Inset bottom: the furnace platform showing control desk and instrument panel.



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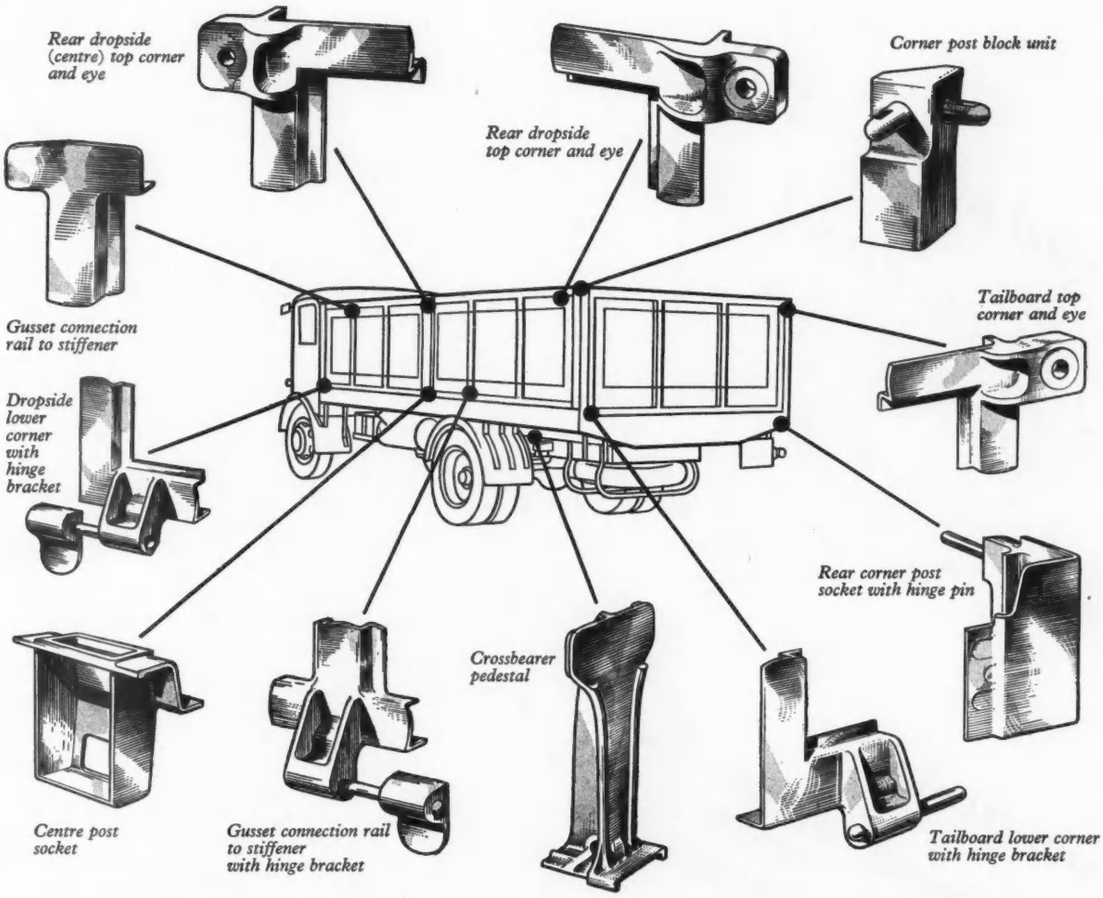
Rear dropside (centre) top corner and eye
Rear dropside top corner and eye
Corner post block unit
Gusset connection rail to stiffener
Tailboard top corner and eye
Dropside lower corner with hinge bracket
Rear corner post socket with hinge pin
Crossbearer pedestal
Centre post socket
Gusset connection rail to stiffener with hinge bracket
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In the construction of this all aluminium body, eighty light alloy castings of special design, produced by William Mills Ltd., are used in conjunction with sheet and sections supplied by The British Aluminium Co. Ltd.

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A good way up
. . . and down!

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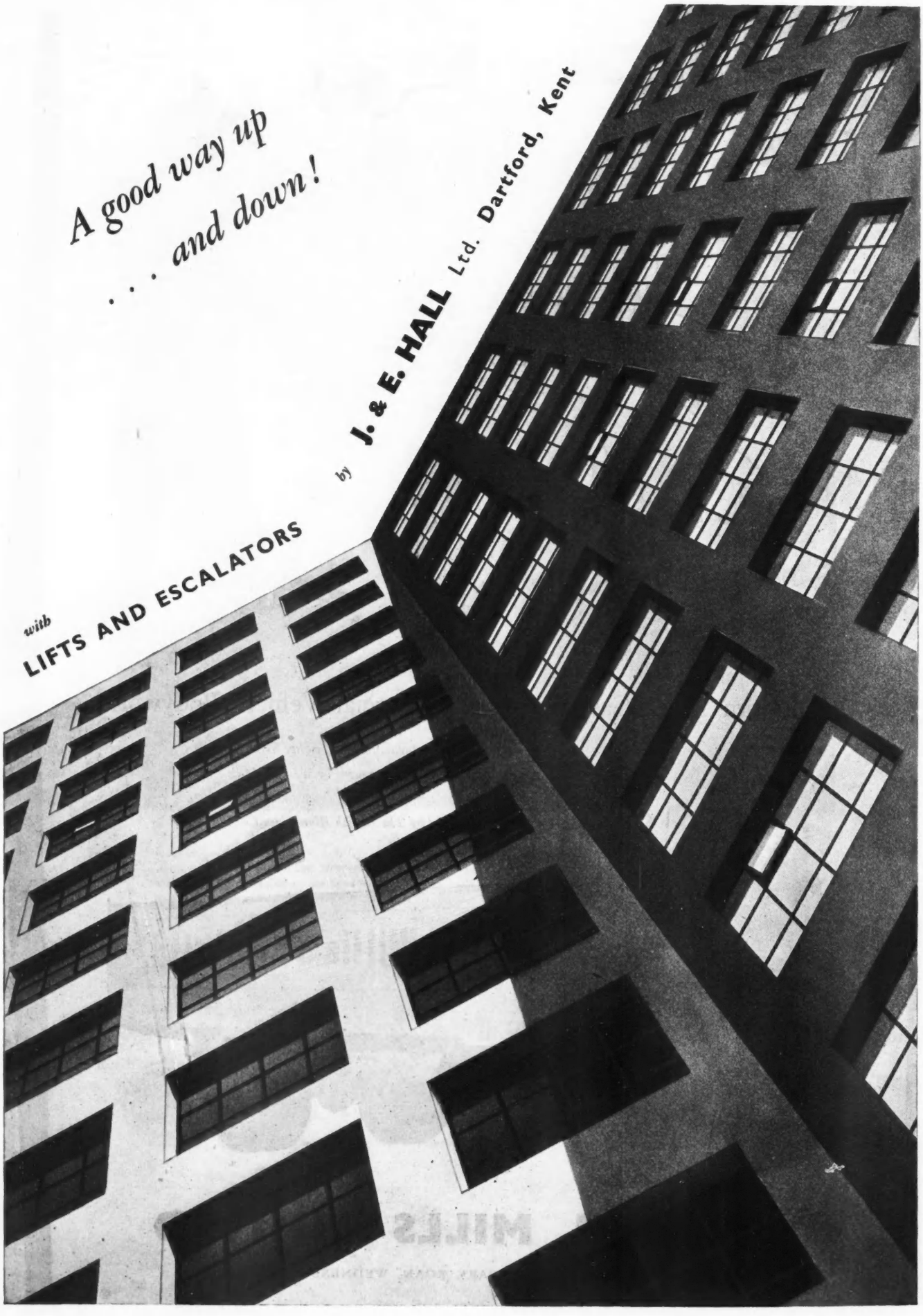

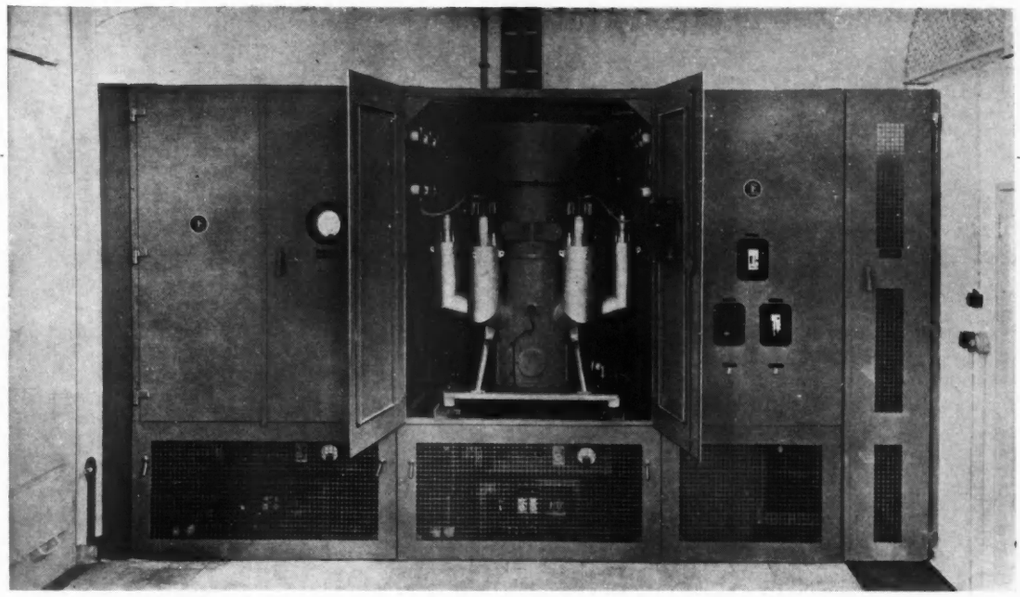

Rectifier equipment supplied to the Netherlands Railways

Twenty 'ENGLISH ELECTRIC' rectifier equipments have been supplied to the Netherlands Railways, each nominally of 1,224 kW, 1,530v, but actually rated at 1,800 kW to meet the heavy-duty cycle which corresponds to a two-hour R.M.S. load of approximately 1,812 amp., following six hours at full load, and includes peaks up to 4,000 amp. for one minute.
The illustration above shows one of these equipments installed in the Hulshorst substation, while the view below shows the exterior of a substation and the 1,800 kW 'ENGLISH ELECTRIC' rectifier transformer.
For more than 70 years, The ENGLISH ELECTRIC Company have supplied electric traction equipments, complete locomotives and rolling stock, also power station and substation equipment, to railways in many parts of the world.

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mercury-arc rectifiers

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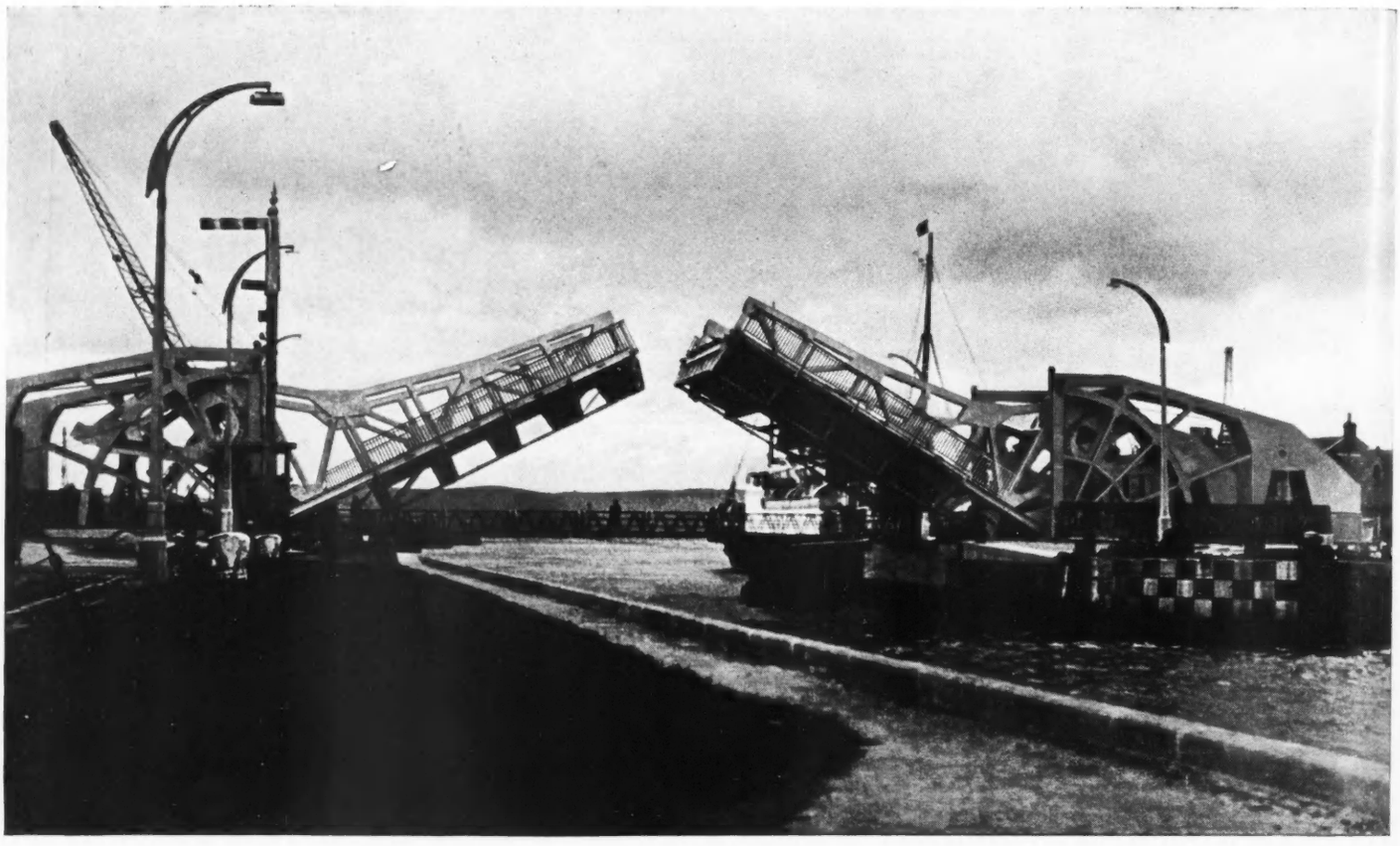

Scotland's first *Aluminium* Bascule bridge

The new bridge at Victoria Dock, Aberdeen, to be known as St. Clement's Bridge, opened by H.M. Queen Elizabeth the Queen Mother on September 30th, 1953, is Scotland's first aluminium bascule bridge. It was developed by the Harbour Engineer, John Anderson, Esq., M.I.C.E., M.I.Struct.E., M.Inst.T., whose decision to use light alloy construction was based on the example of the aluminium bascule bridge at Sunderland. Construction and erection were undertaken by Messrs. Head, Wrightson Aluminium Co. Ltd. of Thornaby on Tees, who had built the Sunderland bridge. The extensive use of aluminium enabled the contractors to build the quadrants and moving leaves as large prefabricated units. This made possible a trial erection at the works, following which the whole of the structural units, by virtue of their light weight, were transported to the site by coaster in one trip. Erection was rapid and was carried out without the need for special equipment and without any interruption to shipping traffic. Because of the low weight of the aluminium structure and the consequent reduction in weight and dimensions of the operating machinery, the total load imposed by the bridge was very low and necessitated the minimum of alteration to the structure of the quay. The British Aluminium Co. Ltd. supplied strong alloy plate used in the construction of this bridge.

THE BRITISH ALUMINIUM CO LTD

NORFOLK HOUSE ST JAMES'S SQUARE LONDON SW1

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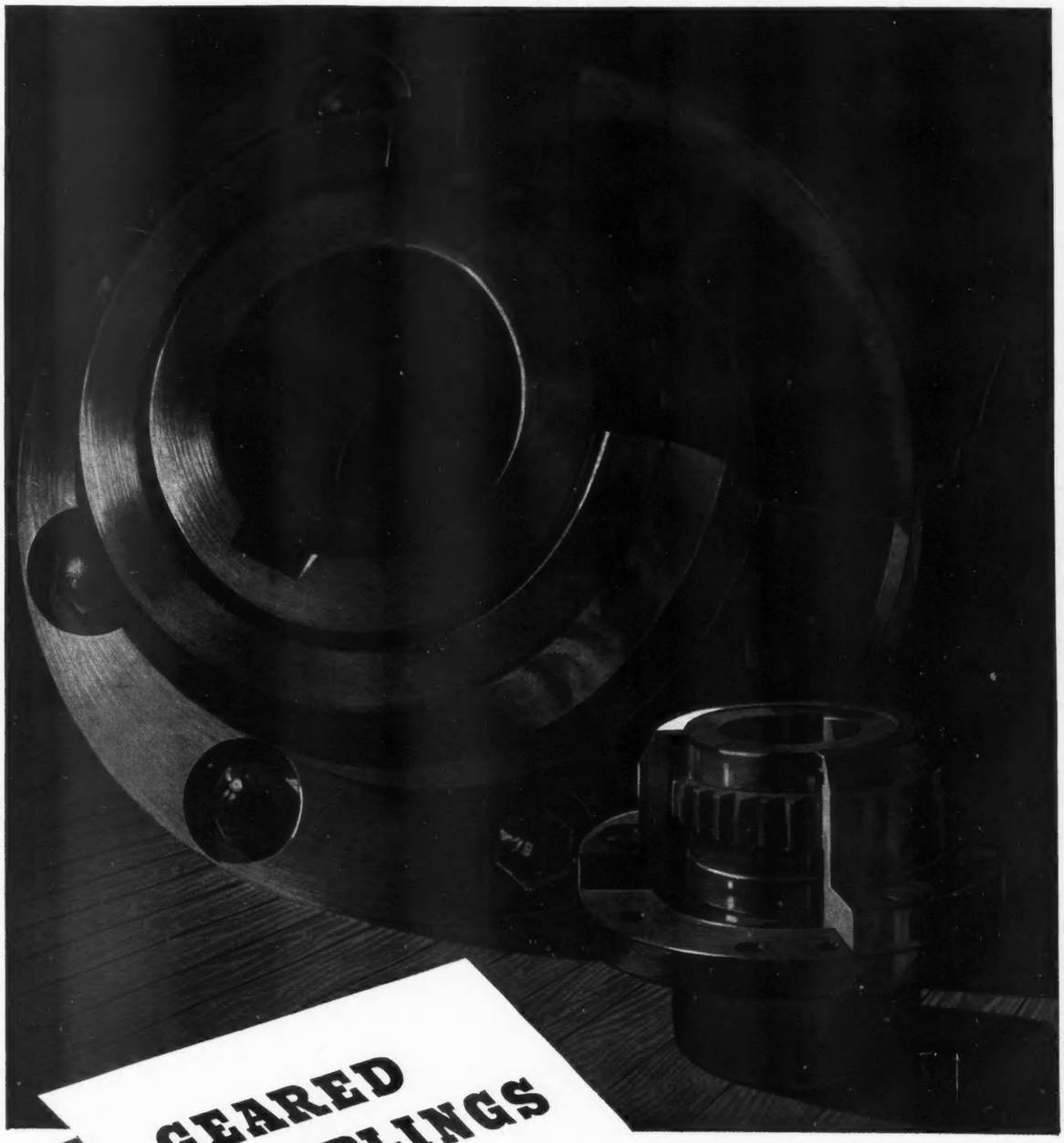

GEARED COUPLINGS

Moss Gear geared couplings are designed to compensate for shaft misalignment caused by changes of temperature, subsidence of foundations or vibration, and to allow the free lateral float of connected shafts. The shock of sudden reversal is adequately borne by these geared couplings without damage to themselves or to the machines they connect.

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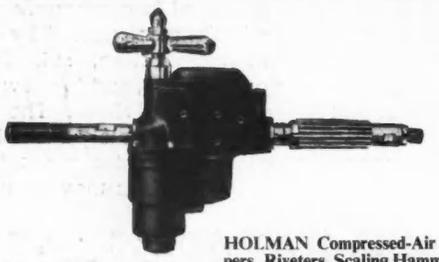
Service without a break



Whatever his line of country, the engineer who specifies HOLMAN PNEUMATIC Tools is always assured of wholehearted service in two respects : from soundly designed equipment and from an after-sales organization that will provide real help at all times and in all places.

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